DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

EDITED BY EDWARD LIVEING, B.A.
SCIENTIFIC ADVISER: A. S. RUSSELL, D.Sc.

Vol. II, No. 21. SEPTEMBER 1921 (Annual Subscription 12s. 6d. Post Free) PRICE 1s. NET

A TYPICAL VILLAGE STREET IN RURAL JAPAN
The woman is washing her rice cauldron

CONTENTS

JOHN MURRAY, 50A ALBEMARLE STREET, LONDON, W.1.

V

D
le

N
sh
ac

Lo
sh

S.

1s

2s

Tr
ha
ma
ce
co
ar
Vi
we
we
at
ar
an
un
to-
(a)
is,
are
in
no
hel

DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

Vol. II, No. 21. SEPTEMBER 1921. PRICE 1s. NET.

DISCOVERY. A Monthly Popular Journal of Knowledge.

Edited by EDWARD LIVEING, B.A., Rothersthorpe, Northampton, to whom all Editorial Communications should be addressed. (Dr. A. S. Russell continues to act as Scientific Adviser.)

Published by JOHN MURRAY, 50A Albemarle Street, London, W.1, to whom all Business Communications should be addressed.

Advertisement Office: 16 Regent Street, London, S.W.1.

Annual Subscription, 12*s.* 6*d.* post free; single numbers, 1*s.* net; postage, 2*d.*

Binding cases for Vol. I, 1920, are now ready. Price 2*s.* 6*d.* net each; postage 7½*d.*

Editorial Notes

THE question of the relations between art and science has recently been revived in the Press and amongst many groups of thinkers. So far as the Press is concerned, this has been partly due to Viscount Haldane's [1] consideration of the meaning of Reality as applied to art and its meaning as applied to science. With Viscount Haldane's subtle distinctions and definitions we do not intend to concern ourselves here. What we do intend to express in these notes is a more practical attitude to the whole subject—an attitude which regards art and science as supremely important one to the other, and as incomplete one without the other. It is an unfortunate fact that many so-called *educated* people of to-day assume one of these two mistaken views: (*a*) that the growth of science is harmful to art, and is, therefore, a danger to civilisation, or (*b*) that these are the days of science, and that art is out-of-date, inefficient, and useless. Put so bluntly as this, these notions seem absurd, but they are in varying degree held by a number of people, and, should you discuss art and science with many men of moderately able intelligence, you will almost certainly find that one or other of these two biasses lies at the back of their minds.

* * * * *

The first belief is a comparatively harmless one, for nothing can now stem the progress of science; it is an essential part of our civilisation; moreover, it is easy to prove historically that science, far from driving art into the background, has often lent it inspiration. We need only mention the discoveries of Copernicus and Galileo, which quite definitely played a part in effecting the Renaissance of European art and literature in the fifteenth and sixteenth centuries, and the great movements in English art and literature during the Victorian era, when science began to make such rapid strides forward, in order to prove our point. But the second bias is far more general and far more insidiously dangerous. In an age of science and mechanical invention such as ours, it is easy to relegate art to the background as something possibly pleasant, but undoubtedly useless. Such an attitude is dangerous not only to art, but to science itself, for art in the wider sense is still the life-blood of science. Nearly a hundred years ago one of the greatest of all lyric poets [2] wrote these words:

* * * * *

"It exceeds all imagination to conceive what would have been the moral condition of the world if neither Dante, Petrarch, Boccaccio, Chaucer, Shakespeare, Calderon, Bacon, nor Milton had ever existed; if Raphael and Michael Angelo had never been born; if the Hebrew poetry had never been translated; if a revival of the study of Greek literature had never taken place; if no monuments of ancient sculpture had been handed down to us; and if the poetry of the religion of the ancient world had been extinguished, together with its belief. The human mind could never, except by the intervention of these excitements, have been awakened to the invention of the grosser sciences, and that application of analytical reasoning to the

[1] *The Reign of Relativity.* (See list of *Books Received.*)

[2] Shelley in *A Defence of Poetry.*

aberrations of society, which it is now attempted to exalt over the direct expression of the inventive and creative faculty itself."

* * * * *

We need not draw any invidious comparisons, as Shelley did in this passage, between science and art. Indeed, they cannot be compared. Both are equally important and, as we have already remarked, either without the other is incomplete. But the main idea of Shelley's magnificent declaration remains true: art is the factor that keeps imagination alive amongst us, and so helps to keep us from becoming morally worthless and intellectually sterile. For it is imagination which quickens the mind of the inventor and researcher, and which drives the explorer into unknown territory. No, in these days, when knowledge is increasing so widely and rapidly, the man of science and the man of art are beginning to realise the value of each other's work. The wider the horizon, the deeper the comradeship.

* * * * *

In the field of co-ordination of knowledge no less than in accurate observation of nature, men like Fabre [1] and Maeterlinck [2] have done most valuable work, for they have given us in fine prose the results of their minute investigations. Mr. H. J. Massingham [3] has applied the careful methods of observation used by Fabre in his study of insect life to the study of birds. *Some Birds of the Countryside,* a book that I have lately had the good fortune to encounter, is more personally written and somewhat less microscopic in its observations than Fabre's work. It endeavours to show birds as part of the beauty of the universe, and so assign them a place in the system of creation. Most of us have hitherto known Mr. Massingham as the driving-power behind the Plumage Act, but in his introduction to *A Treasury of Seventeenth-Century Verse,*[4] published last year, he showed his worth both as a literary critic and as a worker in research; and he now appears as a writer with a broad outlook and a fine, even if at times a rather self-conscious, style.

* * * * *

The most entertaining chapter of the book is that devoted to Charles Waterton, a naturalist of the early nineteenth century, chiefly known for his *Wanderings in South America* (1825). Waterton's jottings on natural history are indeed so interspersed with remarks on politics, religion, and history, and by stretches of autobiography, that they are often more entertaining than instructive. Here is a political jotting: "If driven to extremities, I had rather be slain by the sword of a Tory at noonday than be stabbed at midnight by the muck-fork of a sinuous, tortuous, treacherous Whig. . . . Poor Britain! I pity thee from my heart! What with Jew and what with Gentile, thy Parliament House will soon want a Lord Protector with his whitening brush. 'Sir Harry Vane!' The Lord deliver me from Sir Harry Vane!"

* * * * *

Waterton appears to have gone through a pleasantly adventurous life, according to himself and his Latin-quoting biographer, Dr. Hobson. In his earlier days, for example, he tells us that he strangled boa constrictors in the wilds of Guiana; in latter days we read of him climbing, with his friend Captain Jones, to the head of the guardian angel of the castle of St. Angelo at Rome, "where we stood on one leg"; of a fall from the top of a tree at the age of fifty-eight; of an attempt to fly off the roof of his stables with a pair of self-made wings, from which he was fortunately dissuaded by Dr. Hobson's quotation of the fate of Icarus; and finally of various astounding gymnastic feats in his late seventies. Dr. Hobson tells us the manner in which Waterton in his eightieth year would welcome him "actually dancing down the whole length of the broad walk, occasionally throwing one of his loose slippers from his foot high up in the air above his head and expertly catching it in his hand in its descent," a scene worthy of Alice in Wonderland. Most typical of Waterton's apparent reaction to danger is the following incident: "In 1825 he was in Bruges, when the Belgians were revolting for religious liberty. As the cannon-balls whistled round, he sought shelter at a half-open door. . . . 'Just as I arrived at the threshold a fat old dame shut the door full in my face. "Thank you, old lady," said I; "*Felix quam faciunt aliena pericula cautam.*"' ('Happy she who learns caution from another's danger.')" Well, we can only believe that cannon-balls were not so demoralising as a modern shell!

* * * * *

In the coming conference on Disarmament to be held in the United States, the actors on whom the greatest attention will be focussed will be the envoys from Japan. We may well imagine that they will assume a firm attitude against naval disarmament, but to predict this as a certainty is a very different matter. From the period of the Russo-Japanese War we have become accustomed to regard the Japanese

[1] Fabre is perhaps best known in this country for his books on *The Hunting Wasps, The Mason-Bees,* and *The Life of the Caterpillar.* These and eight other volumes have been translated into English by A. Teixeira de Mattos and are published by Hodder and Stoughton. (8*s.* 6*d.* each.)

[2] *The Life of the Bee,* translated by Alfred Sutro. (Allen & Unwin, 5*s.*)

[3] *Some Birds of the Countryside,* by H. J. Massingham. (See reference under *Books Received.*)

[4] Macmillan and Co.

as a *militaristic* nation and an extremely efficient people quick to take advantage of the intellectual and material characteristics of Western civilisation. But age-long traditions do not pass away in a few decades, and unofficial Japan remains much the same to-day as it has been for the last thousand years. Its people are not imbued with so Prussian a military ardour as might be imagined from journalistic descriptions that have appeared in this country, despite the fact that in war they have shown the world a superb fighting spirit and efficiency. Individually they are a kindly, courteous, and hospitable race, and these virtues are most prominently displayed by the peasants of the countryside, of whom the Rev. Walter Weston gives a description in the present number. This writer has lived the greater part of his life in Japan, and, as the result of many expeditions into the interior, possesses a knowledge, hardly rivalled by any other European, of the subject with which he deals. We hope that his article will clear away some of the journalistic cobwebs about the Japanese that may have gathered in our readers' minds, as they most certainly have in ours.

* * * * *

Another contributor to the present number is Sir William Bragg, well known both as a delightful lecturer to popular audiences, and as one of the foremost of living investigators in experimental physics. His reputation was established when he was professor of mathematics and physics at the University of Adelaide by his work on α-particles and on γ-rays. He returned to England in 1910 to become professor of physics at Leeds, where his work both on γ-rays and X-rays and the structure of crystals led to extraordinarily fruitful and important results. Later he became professor in London. In 1915 he and Prof. W. L. Bragg, of Manchester, his son, were awarded the Nobel Prize in physics for their work on crystal-structure.

* * * * *

The British Association is meeting this year at Edinburgh from September 7 to September 14. The following are some of the subjects to be discussed at joint meetings of sections: The Age of the Earth, Langmuir's Atomic Theory, Vocational Training and Tests, the Relation of Genetics to Agriculture, and the Origin of the Scottish People. The popular evening lectures will be given by Prof. C. E. Inglis, of Cambridge, on the Evolution of Cantilever Bridge Construction, and by Prof. W. A. Herdman, of Liverpool, on Oceanography.

* * * * *

These subjects are all of importance. To Scots the Origin of the Scottish People is a matter of great interest. Vocational Training and Tests, and the Relation of Genetics to Agriculture, are questions which are coming more and more into the public notice, and are of great importance to our intellectual and physical welfare. The age of the earth is an ideal subject for a joint sectional meeting, because there are so many points of view to be tersely expressed and trenchantly criticised. And there is always The Man-With-Some-New-Facts who may come along and induce his audience to add a couple of nothings to the somewhat extended period of time during which this dear old earth of ours has kept going. Chemists and physicists will discuss Langmuir's theory. Dr. Langmuir is an American, well known for his researches in advanced electricity. His theory of the atom is at present regarded as highly ingenious, but somewhat ingenuous and of the bring-it-down-to-the-level-of-the humblest-student type. It will be interesting to see how the theory is received at Edinburgh, and what comes of the discussion. Apropos of this, it was stated recently by a "well-known authority" that the structure of the atom was so large a subject of research that, in spite of the great progress made in the past decade, it would engross the attention of the best workers for twenty-five years more at least.

* * * * *

Our readers may have noticed the correspondence columns in the August number of our journal. We are not referring to those letters in particular when we say that DISCOVERY, aiming as it does at giving information on all branches of knowledge, is always ready and, indeed, grateful to receive and to publish reasonable criticism and suggestion with regard to any articles that appear in its pages. An actor who does not feel the pulse of his audience risks certain failure; and a paper that will not admit to its columns the views of its readers merits a like fate. DISCOVERY exists for its readers, and it desires their co-operation in its aim of getting at the truth.

* * * * *

In the October number of DISCOVERY, Professor T. E. Peet, of Liverpool University, will give an account of his recent work on the site of the city of the sun-cult at Tell-el-Amarna (Assiut Province, Upper Egypt), where the Germans did a vast amount of excavating before the war. This immense city was built by Amenhotep IV (1375–1358 B.C.)—a monarch with ideals, who attempted to implant sun-worship as a monotheistic religion in Egypt. Since the war, Professor Peet has carried out considerable researches at Tell-el-Amarna. The editor found him there last March, living in a dwelling reconstructed by the Germans from one of the city's several thousand ruined houses.

Electrons and Ether Waves[1]

By Sir William Bragg, K.B.E., F.R.S

Nobel Laureate; Professor of Physics in the University of London, University College

I PROPOSE to ask you to consider for a short time one of the outstanding problems in Physics. I am justified, I think, in saying that so far it has proved insoluble, but for all that, it lacks neither interest nor importance. It is important because it relates to very fundamental things with which we are deeply concerned, and as to its interest, it comes in many ways.

Man's interest in radiation is naturally very old indeed. The warmth of the sun, the light that it gives by day, and the light of the moon and stars by night, fill a first place in their importance to him. When experimental science began to grow rapidly, its first efforts were devoted to an attempt to unravel the laws of propagation of light and heat. Among the famous pioneers Newton and Huyghens represented two opposing schools of thought. The former advocated a corpuscular theory of light, the latter maintained that light consisted of a wave motion. In a restricted sense, the wave theory has completely triumphed; it explains the ordinary phenomena of light and especially of the intricate effects which depend on interference of waves with the greatest satisfaction and precision. But, on a wider view of light phenomena, the victory of the wave theory is not so absolute, for it is certain that a great part is played by corpuscular radiations, the corpuscles being the electrons of recent discovery. It seems that we must admit the importance of each view and, to a certain extent, we can accurately define the part that each must play: but, there is one great exception. There is one problem in connection with the interrelations of electron waves and corpuscles which seems to ridicule all our attempts to understand it. If we could solve it we should have made an immense advance, both in knowledge and in our power of handling materials. We should perhaps have added a new province to the realms of physical thought. And it is because of this obvious importance and because of our failures to find the solution that I hope you will be interested in looking at the question once again in the light of recently acquired knowledge.

We are going to consider the relations between the energies carried by ether waves and the energy carried by electrons. Let us first set down the distinctive features of each form of radiation. As regards wave radiation, we must say that the energy spreads outwards and weakens as it spreads, just as a sound dies away in the open air. And next we must add that all waves show the extraordinary phenomenon of interference. Two sets of waves can tend to destroy each other's actions at certain places and times, making good such losses by increased actions at other places and other times. By the aid of this principle Young and Fresnel, and a host of workers who have followed them, have built up optical theories of great power and completeness. Note that the characteristics of a simple wave are its length[2] and its amplitude[3]: it has no others.

Corpuscular radiations have been obvious to us on the grand scale only since the discovery of radium and of X-rays. Beside the α-rays, the projection of helium atoms from the bursting atoms of radio-active substances, we find in the general radiation of radio-active substances streams of high-speed electrons. The main features of these rays which concern us now can also be stated briefly:

Electrons are to be found everywhere forming part of every atom. They can be set in motion by electric forces, as in the X-ray tube, or they may be expelled from radio-active substances. Such radiation, like light radiation, has qualities. The flying particles may be more or less in number, and the speed of each can fall between wide limits. In other respects it is, at present, assumed that they are all like each other. We have not been acquainted with electron movements so long as we have been acquainted with wave motions in ether. The reason is perhaps a simple one:

An electron can only maintain a separate existence if it is travelling at an immense rate, from one three-hundredth of the velocity of light upwards, that is to say at least 600 miles a second or thereabouts. Otherwise the electron sticks to the first atom it meets. The action of a powerful induction coil and space to move in freely, where there are no atoms to impede it, provide favourable circumstances for observation, and we have only been able to realise these conditions with sufficient success in more recent years.

We now know, therefore, radiation in two forms, and each is independently full of interest. But it is the extraordinary connection between them that is so fascinating and yet beats us when we try to explain it. We have known for many years that there is some connection between waves and electrons, because light, especially of short wave length, can cause a discharge of negative electricity, that is to say, of electrons, from substances on which it falls. This, which is known as the photo-electric effect, has been carefully examined

[1] This lecture was given in May to the Oxford University Junior Scientific Club, and is here reproduced by their kind permission. It is published in separate form by the Oxford University Press at 1*s*.

[2] The distance between adjacent crests.

[3] The maximum distance from the mean position attained by a vibrating particle.

with a view to discovering the relations between the wave length of the ether radiations and the velocity of the ejected electrons. But the experimental difficulties of obtaining a close insight into the effect were always considerable until we had to do with the new variety of light which Röntgen discovered in 1895. The very short wave length which is associated with X-rays goes with a photo-electric effect which is so greatly intensified that we can examine it in detail, and now the relation between wave and electron takes on an importance which arrests attention.

We can take the question in two stages: in the first as a general question. In the second we bring in effects which depend on details of atomic structure.

The general question can be stated quite simply. We have seen that a wave motion is defined by two qualities. The one the wave length; the other the amplitude. When an X-ray falls upon any material substance we find that electrons are ejected; the wave radiation has produced an electron radiation. Electron radiation has characteristics also, namely, number and speed. In what way, then, are the characteristics of the waves related to the characteristics of the electron movements which are excited by them? The answer is simple but surely unexpected. The velocity of the electron depends on the wave length only; the number of electrons depends on the intensity, but not on the wave length. Moreover, the relation between the wave length of the one radiation and the velocity of the other is of the simplest kind. If we define the wave length by stating the number of waves that pass by a given point in a second and call this number the frequency, then the energy of the electron is equal to the frequency multiplied by a constant quantity. This constant is not new to us, it had already turned up in connection with investigation of interchange of energy, where waves are concerned, and is well known as Planck's constant. That, however, need not concern us now.

The essential point is that a wave radiation falling on matter of any kind whatever and in any physical condition, liquid or solid or gaseous, hot or cold, causes the ejection of electrons. In actual experiment we cannot usually examine the speed of the electron at the instant of its production. We have generally to wait for the electrons to get outside the body in which they arise before we can handle them in our experiments. Those that have come through the deeps of the material have lost speed by collision with the atoms on their way out. Consequently, we have in response to the incidence of waves of a definite frequency, that is to say, of so-called monochromatic radiation, an output of electrons of various speeds ranging downwards from a maximum which is given by the above-mentioned relation. There does not seem to be any doubt that the electrons all had originally quite the same definite speed, and that the differences in speed are acquired subsequently.

In this process we see energy of wave radiation replaced by energy of electron radiation. There is an exactly converse process. If we direct a stream of electrons against any material substance we can call into being ether waves. They arise at the point of impact, and their quality is, in the general sense, determined by the velocity which we have given the electron stream.

Among the waves so originated there are some whose frequency is related to the energy of the individual electron in the electron stream by the same constant as before. There are others of lesser frequency, such as we might suppose to be originated by electrons that belonged to the original stream, but have lost energy by collisions with the atoms of matter. Here, again, there is no doubt that the electrons produce waves for which the frequency is exactly determined by the use of Planck's constant as above.

In order to realise the full significance of these extraordinary results, let us picture the double process as it occurs whenever we use an X-ray bulb. By the imposition of great electrical forces we hurl electrons in a stream across the bulb. One of these electrons, let us say, starts a wave where it falls. This action is quite unaffected by the presence of similar actions in the neighbourhood, so that we can fix our minds upon this one electron and the wave which it alone causes to arise. The wave spreads away, it passes through the walls of the bulb, through the air outside, and somewhere or other in its path, in one of the many atoms it passes over, an electron springs into existence, having the same speed as the original in the X-ray bulb. The equality of the two speeds is not necessary to the significance of this extraordinary effect; it would have been just as wonderful if one speed had only been one-half or one-quarter or any reasonable fraction of the other. The equality is more an indication to us of how to look for an explanation than an additional difficulty to be overcome.

Let me take an analogy. I drop a log of wood into the sea from a height, let us say, of 100 feet. A wave radiates away from where it falls. Here is the corpuscular radiation producing a wave. The wave spreads, its energy is more and more widely distributed, the ripples get less and less in height. At a short distance away, a few hundred yards perhaps, the effect will apparently have disappeared. If the water were perfectly free from viscosity and there were no other causes to fritter away the energy of the waves, they would travel, let us say, 1,000 miles. By which time the height of the ripples would be, as we can readily imagine, extremely small. Then, at some one point on its circumference, the ripple encounters a wooden

ship. It may have encountered thousands of ships before that and nothing has happened, but in this one particular case the unexpected happens. One of the ship's timbers suddenly flies up in the air to exactly 100 feet, that is to say, if it got clear away from the ship without having to crash through parts of the rigging or something else of the structure. The problem is, where did the energy come from that shot this plank into the air, and why was its velocity so exactly related to that of the plank which was dropped into the water 1,000 miles away? It is this problem that leaves us guessing.

Shall we suppose that there was an explosive charge in the ship ready to go off, and that the ripple pulled the trigger. If we take this line of explanation we have to arrange in some way that there are explosive charges of all varieties of strength, each one ready to go off when the right ripple comes along. The right ripple, it is to be remembered, is the one whose frequency multiplied by the constant factor is equal to the energy set free by the explosion. The ship carries about all these charges at all times, or at least there are a large number of ships each of which carries some of the charges, and externally the ships are exactly alike. Also we have to explain why, if we may drop our analogy and come back to the real thing, the ejected electron tends to start its career in the direction from which the wave came. This is a very marked effect when the waves are very short.

Dropping the analogy, how do the electrons acquire their energy and their direction of movement from waves whose energy and momentum have become infinitesimally small at the spot where they are affected, unless the atom has a mechanism of the most complicated kind? And if the intervention of the atom is so important, why is it that in these effects a consequence of the intervention does not depend upon each atom itself—whether, for example, it is oxygen or copper or lead?

We may try another line of explanation and suppose that the energy is actually transferred by the wave from the one electron to the other. If it is the atom which pulls the trigger and causes the transformation, then how does it happen that the whole of the energy collected by the wave at its origin can be delivered at one spot? Rayleigh has told us that an electron over which a wave is passing can collect the energy from an area round about it whose linear dimensions are of the order of the wave length. But any explanation of this kind is entirely inadequate. Whatever process goes on, it is powerful enough on occasion to transfer the whole of the energy of the one electron to the other. Nor can there be any question of storing up energy for a long period of time until sufficient is acquired for the explosion. For it is not difficult to show that when an X-ray bulb is started and its rays radiate out, the actual amount of energy which can be picked up by an atom a few feet away would not be sufficient for the ejected electron, though the tube were running for months; whereas we find the result to be instantaneous.

I think it is fair to say that in all optical questions concerned with the general distribution of energy from a radiating source the wave theory is clearly a full explanation. It is only when we come to consider the movements of the electrons which both cause waves and are caused by them that we find ourselves at a loss for an explanation. The effects are as if the energy were conveyed from place to place in entities, such as Newton's old corpuscular theory of light provides. This is the problem for which no satisfactory solution has been provided as yet; that, at least, is how it seems to me.

No known theory can be distorted so as to provide even an approximate explanation. There must be some fact of which we are entirely ignorant and whose discovery may revolutionise our views of the relations between waves and ether and matter. For the present we have to work on both theories. On Mondays, Wednesdays, and Fridays we use the wave theory; on Tuesdays, Thursdays, and Saturdays we think in streams of flying energy quanta or corpuscles. That is, after all, a very proper attitude to take. We cannot state the whole truth since we have only partial statements, each covering a portion of the field. When we want to work in any one portion of the field or other, we must take out the right map. Some day we shall piece all the maps together.

Meanwhile, even if we cannot explain the phenomena, we must accept their existence and take account of them in our investigations. We must recognise that wave radiation and electron radiation are in a sense mutually convertible. Whenever there is one there must be the other, provided only there is matter to do the transforming. We do not yet know more than a little of the part that this process of interchange plays, but we know that it is very prominent when the waves are very short, or, what is the same thing, the electrons moving swiftly. It is the movement of the electrons in the X-ray bulb that originates the X-rays themselves. They as waves pass easily through the wall in the tube and through materials outside; their energy finally disappears and is replaced by moving electrons. It is the latter alone that produce directly the effects which we ascribe to X-rays. We may suspect that similar effects to these take place when the waves are long, but the corresponding electron velocities are so small that it is difficult to measure them or observe their effects. Nevertheless, the carrying forward to these regions of experience gained elsewhere has led to extraordinary results, as,

for example, in the theories of Bohr regarding the relations between the structure of an atom and the radiation it emits.

I have spoken of the first stage in this examination of the relations between ether waves and electrons. May I now go one step further and bring in certain curious and lately discovered relations between the interchanges and the nature of the atom itself ? All that I have said before is mainly independent of atomic nature ; I want now to consider certain experimental results which are superimposed upon the former without in the least invalidating them, and which obviously have a first importance on our appreciation of atomic structure.

When an X-ray of given wave length strikes an atom, it may result in the ejection of an electron of equivalent energy as described above. And in such a relation between wave length and energy there can be no trace of any influence of the nature of the atom. But it may sometimes happen that the energy, instead of being handed over or transformed in one complete whole, is transformed in a series of successive stages, and these stages are really characteristic of the atom. Let me give an illustration :

Let us imagine an X-ray of wave length equal to two-tenths of an Angström Unit (100-millionth of a centimetre), such as comes, under ordinary circumstances, from a powerful X-ray bulb. It falls on a silver atom ; it may, as in the general process, produce an electron of energy equivalent to itself, but it may also divide up this energy into two parts. One part is characteristic of the silver atom. It is an amount which the silver atom is for some reason especially liable to absorb or develop. It is peculiar to the silver atom, no other atom absorbs just that quantity. Leaving out of account for the moment the balance, let us follow the course of happenings to this particular quantity of energy. It excites in the atom a series of rays characteristic of the atom. These rays are divided into groups characteristic of the atom, but of a general arrangement which is the same for all atoms. It appears that the absorbed energy is divided up between various rays, probably giving rise to one out of each group, and in that ray its whole total is spent.

These rays we now analyse with an X-ray spectrometer [1] using a crystal as our diffraction grating. It is by their use that we have been able to study the architecture of crystals and to find the way in which the atoms, under the influence of their mutual force, arrange themselves in crystalline form.

Going back for a moment to the balance, the difference between the energy characteristic of the original X-ray and that amount of energy which was used up in the way just described, this energy, it appears, is found in the possession of an electron whose velocity can be measured with accuracy. Here we have an extraordinary instance of a partition of energy between wave and electron. We find the action of a wave resulting in the initiation of both electrons and waves, but the simple relation which we had in the general case is only modified to a slight degree. There may be several items instead of one in our balance sheet, but the balance is still good. This action follows just as well as a consequence of the impact of an electron having the necessary energy as it does from the incidence of an X-ray in the way I have described. We should notice in addition that when X-rays or electrons fall short in their associated energy of the amount characteristic of the atoms, there is no result at all, and this is reflected in the fact that neither of them is absorbed in the atom so much as if they were respectively a little higher in frequency or a little greater in velocity.

The curious and essential feature of all this mass of information which I have been trying to put before you in a rough and summary form is the interchangeability of ether waves and electrons. Energy can be transferred from one to another through the agency of matter. The transference is governed by the simplest arithmetical rules. In the exchange it is the frequency of the wave which is to be set against the energy of the electron, and it is just this that makes the greatest puzzle in modern physics. It is the block at one point which is choking the entire traffic, and on which, therefore, all our interests must concentrate.

ADDENDUM [2]

The interchange of energy between wave and electron has recently been examined from a new point of view, with very interesting results. It is well known that each atom can be stimulated under the proper condition to the excitement of X-rays characteristic of the atom. For instance, tin atoms can be made to emit a certain series of "lines" known as the K series, provided that the incident and exciting radiation is, if a wave, of shorter wave length than 0·421 Angström Units ; or, if an electron, of the corresponding quantum energy.

The actual measure of the "critical quantum energy" of the wave or the kinetic energy of the electron is

$$6{\cdot}55 \times 10^{-27} \times 3 \times 10^{10} \div 0{\cdot}421 \times 10^{-8} = 4{\cdot}67 \times 10^{-8} \text{ ergs.}$$

When the quantum energy of the exciting radiation exceeds this amount the whole K series is excited; the quantum energies of the principal members of the series are 4·55 and 4·02, the unit being 10^{-8} ergs.

Tin, like other atoms, has other characteristic radiations; in particular, there are certain so-called L series whose quantum energies are about one-eighth of those of the K series ; and again, there are M series of still smaller energy, and no doubt others amongst which quanta of visible light are included. It is sufficient for present

[1] See DISCOVERY, vol. i, p. 31, for an article on this subject by Professor W. L. Bragg.

[2] The author has added these notes for the benefit of readers who have been studying work on X-rays in some detail.—A. S. R.

*

description to assume that the L series have on the average a critical quantum energy 0·65 and the M series 0·12.

Two questions now arise: (1) If the critical energy 4·67 represents, as is natural to assume, an energy given up by the incident radiation to the atom, what becomes of the balance when the radiation 4·55 or alternatively 4·02 is excited in the atom? (2) If the energy of the exciting radiation exceeds 4·67, what becomes of the excess?

The answer to the first appears to be supplied by the observation that $4{\cdot}67 - 4{\cdot}55 = 0{\cdot}12$ (M) and $4{\cdot}67 - 4{\cdot}02 = 0{\cdot}65$ (L).

It seems to be the general rule, verified carefully by Duane (*Physical Review*, December 1920), that the difference between two critical quanta is equal to a wave quantum.

An answer to the second question is given by de Broglie (*Comptes rendus*, March 29, 1921), whose experimental results agree with the hypothesis that the excess of the incident quantum energy over the critical quantum energy appears subsequently as the energy of a high-speed electron. De Broglie examined (with other similar cases) the magnetic spectrum of the electron radiation arising from the incidence of rays characteristic of tungsten upon a tin radiator. The two principal incident radiations had quantum energies 10·62 and 9·40; they were, in fact, the K lines of tungsten. In the magnetic spectrum were found five groups of electrons; one of these had a maximum energy 5·9 which is equal to $10{\cdot}62 - 4{\cdot}67$ within experimental error; the maximum energy of the other was 4·7, which is very nearly $9{\cdot}40 - 4{\cdot}67$.

In this case, then, the difference between the energies of the exciting quantum and of the critical quantum is equal to the maximum energy of a group of electrons which is found in the magnetic spectrum.

Three other groups of electrons were found by de Broglie on his plates. Their maximum energies were 4·4, 3·9, and 3·4. These were to be expected, since the characteristic rays of tin, 4·55 and 4·02, were present, having been excited by the tungsten rays of superior quantum energy, and, in further sequence to the rule just stated, there ought to be electron groups having respectively maximum energies equal to $4{\cdot}55 - 0{\cdot}12 = 4{\cdot}43$, $4{\cdot}55 - 0{\cdot}65 = 3{\cdot}90$, $4{\cdot}02 - 0{\cdot}12 = 3{\cdot}90$, and $4{\cdot}02 - 0{\cdot}65 = 3{\cdot}37$.

Parallel results in the case of X-rays have been obtained by C. D. Ellis, under the direction of Rutherford. They are described in the *Proceedings of the Royal Society*, June 1921.

OUR CONTEMPORARIES

The July *Psyche* (5*s*.) (the new and more ambitious form of the original *Psychic Research Quarterly*) has some highly interesting articles, notably Major Priestley's account of the psychological difficulties of Antarctic Exploration, illustrated by personal experiences, the paper on "Sleep" by Dr. Hartridge and Mr. Whately Smith, and a note on the "Tudor-Hart Theory of Colour." The last-named article touches on ground where the account of "Revolutionary Movements in Modern Painting" in the August issue of DISCOVERY made a halt. The August *Geographical Journal* contains a first instalment of an account by Mrs. Rosita Forbes of her hazardous journey to the Kufara Oasis. In *Science Progress* for July, Professor Bragg, of Manchester, writes on the dimensions of atoms and molecules, and Dr. Atkins on Natural Indigo.

Rural Japan

By the Rev. Walter Weston, M.A., F.R.G.S.

Late British Chaplain at Yokohama

OF all the poetic titles by which the Japanese in ancient days delighted to designate their beautiful land, the most ancient was that of *Toyo-ashiwara-Mizuho-no-Kuni*—" the fertile reed-clad country rich in grain." In this we have the intimation that from the remotest ages of the national existence it is agriculture that has been the occupation of the majority of the people, and their most fruitful source of livelihood. The sudden emergence of modern Japan from her hermit-like seclusion of former days into the roar and rush of intercourse and competition with the Western world has blinded the eyes of most passing observers to that which forms the real basis of the national prosperity. It is in the country-side that we look upon the most characteristic features of the life of the people, and the traveller can only properly appreciate the real strength of national organisation, and the most attractive aspects of the national character, when he leaves the crowded cities and the beaten tracks of Westernised Japan for the fields and farms of the most intelligent and hospitable peasantry in the world.

In spite of the rapid progress of manufacturing and mining industries in recent years, it is agriculture that still stands first as the greatest means of the wealth and power of the people of Japan. The rural population number 60 per cent. of the whole, and it is they who supply the Empire with nearly all its food and drink, and with the greater part of the raw materials for manufactures. There are now no large landed proprietors, and a feature of agriculture is that it means the tillage of small holdings, not merely by the farmer or the peasant himself, but with the help of sons, wife, daughters, and every member of his household. The land really does belong to him, for the doctrine that all is the property of the Emperor is a mere legal fiction, and it is no wonder, therefore, that the man "on the land" works as few peasantry in the world have ever been known to work. Only about 12 per cent. of the whole area of Japan is cultivable, and even this is not naturally very fertile. It is only made to yield its utmost by the minutest and most careful system of subsoil working, manuring, terracing and irrigation, and these are carried on with a care and thoroughness that almost suggests gardening rather than farming. There is practically no machinery employed, and nearly all the work is done by hand, hoe and spade, helped out at times by the ox or the horse.

It is in the task of their subjugation of the land to

the service of man that the best characteristics of the Japanese people have been developed—their boundless patience and perseverance, their intelligence, ingenuity, and self-control, their tough constitutions and temperate habits. Some of the finest fighting men in the army are drawn from the peasant classes—hardy, stolid and entirely unafflicted with nerves. Most of them come from the hill country, and their surroundings have left their impress on their character and habits. It was remarked by British officers during the Russo-Japanese War that, in districts where long marches had to be made over routes chiefly leading along goat-tracks or across pathless gullies and crags, each man having to find his own way and to meet his company again on the other side, it was the native mountaineering habitudes of the lower ranks that led them to take the least inaccessible line of country. In mountain warfare the hill-men among the Japanese infantry displayed—as compared with other infantry—some of the attributes and mobility of cavalry. Moreover, there is something in the open and communistic character of the daily life of the country people (for to them privacy is an unknown condition) that renders them natural and considerate, and promotes a resourcefulness and readiness to help each other that must be experienced to be understood. It is among such as these that one finds human nature most unsophisticated and unspoilt, nor has all that is artificial and materialistic in our vaunted twentieth-century civilisation yet laid a paralysing hand upon that inborn simplicity and courteous bearing which in days gone by did so much to justify the title by which the Japanese delighted that their land should be known—*Kunshi no Koku*—" the Country of Gentlemen."

One of the most striking features of the country-side, to one who wanders out from the crowded life of the great towns, is the extraordinary and minute care with which the hills, rising abruptly as most of them do from the alluvial plains and the seashore, are terraced from base to summit wherever a single ear of rice or corn can be made to grow, the resultant landscape resembling nothing so much as a gigantic chessboard decked in yellows, golds and greens of every shade. A story is told of the diligence so characteristic of these tireless toilers that one farmer terraced *his* little hill-sides into no less than eleven tiers. Then he sat down on the summit to rest and survey in triumph the prospect at his feet. To his dismay he could count but *ten* of the terraces he had shaped. The eleventh was there, but invisible, for he was sitting upon it! What makes these agricultural achievements the more astonishing is the fact that they are attained with the most primitive of instruments, for the peasantry are the most conservative class in the nation. The whole of their agricultural system was borrowed from China nearly two thousand years ago, and has known practically no change; the plough they use is that of the Egyptians of the days of the Pharaohs, and spade, hoe, sickle, harrow and flail differ but little from those of their first instructors. On the other hand, however, the wagon and the wheelbarrow are almost unknown.

Of all the most ancient and popular festivals of Japan, those that are celebrated with the geatest zest and enjoyment invariably belong to the life of the country-side, and form a standing witness to the primeval and paramount significance of agriculture to the entire nation. The so-called " national ones," dealing with alleged historical events, are of official origin, and nearly all quite modern. Their observance is chiefly confined to the large towns, and exercises comparatively slight influence on the popular sentiment or imagination. To the outer world the former are sufficiently unfamiliar and significant to deserve record by way of illustration.

A TYPICAL VILLAGE STREET IN RURAL JAPAN.
The woman is washing her rice cauldron.

One of the earliest in the year is that of Inari-Sama, the Goddess of Food, at whose gaily decorated shrine services of intercession are held on the first day of the second month (old style), i.e. March, on behalf of a fruitful rice-harvest later in the year. Inari-Sama (about whose sex there is some ambiguity), is sometimes spoken of as the Fox-Goddess, and is commonly identified with her servant the fox. In view of the all-importance of rice to the whole nation, it is natural that this divinity should be held in such honour, not to say dread, and we find that these festal gatherings partake of the nature of a combination of communion, eucharist, and love-feast. Papers stamped with the picture of a fox are pasted on cottage doors as charms of exceptional potency. The animal is credited with supernatural powers of bewitchment, and the belief in *Kitsune tsuki*—"Fox-possession "—is very real and widespread. It belongs to a class of folk-lore and superstition of which little is known in this country,

and but half-acknowledged by the educated Japanese themselves, though it is of psychological and scientific interest to the student and the medical man.

Japan is one of the most richly watered countries in the world, and as nearly all swift-flowing rivers and impetuous mountain torrents have their own presiding divinities, we are not surprised to find them credited with power to hurt or help the lands through which their waters pass. In districts liable to damage through inundations, services of intercession are held in the third month, our April, and at popular shrines like those of the River Goddess of Kofu, in the broad and fertile plain of Koshu, in central Japan. The goddess is taken out for an airing in her sacred car, and earnest supplications are addressed to her for the protection of the fields and farms of the peasantry in the coming days, when, with the melting of the winter snows, and the storms of early summer and autumn, the myriad mountain torrents swell the parent rivers on their resistless course through the cultivated plains to their wide and populated deltas at the sea.

THE TONEGAWA RIVER IN CENTRAL JAPAN.
In the rainy season it is filled with sometimes overwhelming floods.

The month of May sees the country-side under its brightest, busiest, and most varied aspects, and in all its activities nearly everyone, old or young, has his or her part to play. Barley, wheat, and (especially) millet are ripening, and "honourable" tea is now ready to be picked. The grains enumerated are the real staple food of the rural districts, for though all who can live on rice, most of the peasantry, especially in the remoter parts, cannot afford to do so, and only indulge in it on high days and holidays, or in cases of sickness. A friend of mine tells me of an old lady whom he heard remark of a sick neighbour in a country hamlet, with a grave shake of the head, "What! do you mean to say that it has come to giving her rice?" In other words, "The poor thing *must* be in a bad way!"

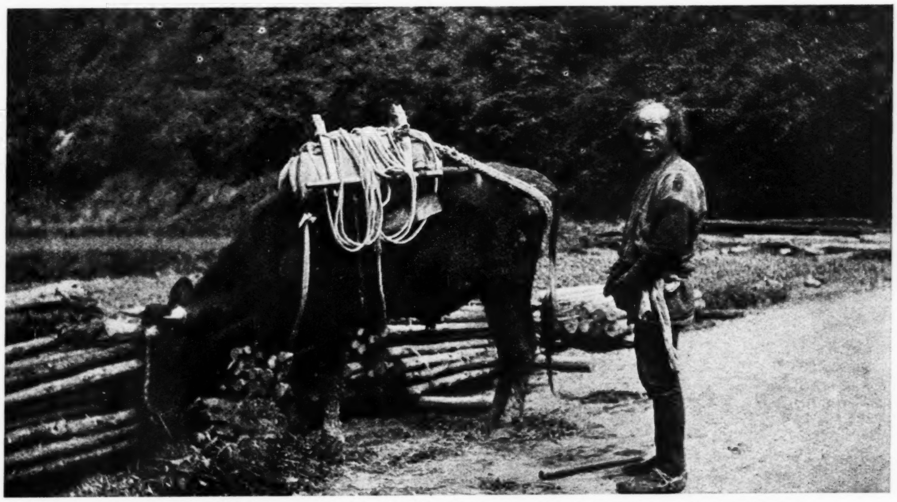
The chief festival of this season is that of the God of Hailstorms, and many an anxious farmer in the silk-producing districts in the great inland provinces of Shinshu and Kofu then visits the ancient village shrine to pray for the preservation of his precious mulberry trees from the dreaded scourge. Strangely enough, however, these are said to be almost immune from lightning, and there is a popular belief that a man caught in the open in a thunderstorm has only to call out "*kuwabara*," i.e. "mulberry grove," in order to surround himself with the prophylactic properties of that valued object and so avert the threatened danger. The Christian Japanese farmer can read with sympathetic interest the story of the plague of hail in Exodus ix, where we learn that "*the flax and the barley was smitten, for the barley was in the ear and the flax was bolled*" (i.e. in bud). Nearly every article of food and domestic utility is committed to the care of its own guardian divinity, and a Japanese writer has observed that, if the interests of the peasantry are not protected by unseen Powers, it is not for want of earnest supplications addressed to them at all seasons and for every possible boon desired.

Of special significance is the festival of the rice harvest, with its twin observances (like those of the ancient Hebrews) of the offering of the First-fruits known as *Kanname-sai*—in the middle of October—with its complement in the *Niiname-sai*—on November 23rd, when the Emperor tastes the new rice that has just been presented at the holiest of all the shrines of Japan

—that of the Imperial Ancestors at Ise—at the climax of the ingathering. The former of these is an essentially popular one, and the best of the precious grain is presented at thousands of village altars throughout the length and breadth of the land. Close by these, on the stages which are usually found at the side of the most ancient shrines and erected for the purpose, a pantomimic dance known as *O Kagura*—" The Seat of the Gods "—is then performed to entertain the guardian divinity in grateful acknowledgment of his kindly care, a thought which is further impressed on the children themselves by the closing of the schools in order to set them free to keep the festival with innocent gaiety. The arrangements which enable neighbouring villages to hold their celebrations on different days, like those in English country parishes at harvest-tide, and so to share their mutual rejoicings, make for a friendly community of interest and neighbourly good feeling.

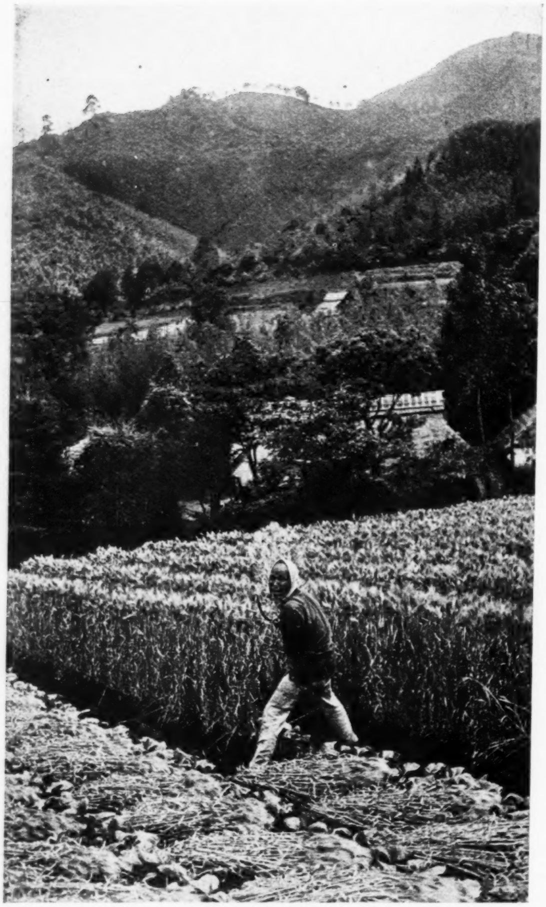
There is one other festival which is highly popular with the peasantry in late autumn, that of *Ebisu*, the God of honest hard work, as well as of wealth. This is kept with twofold energy, partly because all desire to be rich, and partly because, on the basis of " sympathetic magic," it is felt that one who controls the gift of prosperity should naturally be courted with every sign of merriment and enjoyment of the good things of life. At this festival in the province of Kishu, when the procession bearing the appropriate offerings approaches the shrine, the village head-man calls out in a loud voice, " According to our annual custom let us all laugh," to which exhortation a hearty response is given. The reason given for this is that Ebisu alone, of all the eight million divinities, has not gone to visit the great Shinto shrine in Izumo on the annual holiday sacred to them, for he, being deaf, could not hear the summons thither. And so his worshippers seek to cheer him in his loneliness by their own infectious merriment! It is a natural instinct of the human heart to feel that this act must be acceptable to the Object of its most unfettered rejoicings—" *Let us come before his presence with thanksgiving, and show ourselves glad in him with psalms!* "

It is impossible to get a clear idea of the life of rural Japan until we realise the all-importance of the rice-crop to the nation at large. Two-thirds of the cultivated land is devoted to it and no less than 4,000 varieties are produced, while, as we have seen, it is the sowing, transplanting, and ingathering of it that form the chief occasions of popular solicitude and rejoicing. Until, at the Restoration in 1868, the Daimyo—the old feudal lords—retired into private life, their incomes were paid in rice, and to-day the peasants pay their rent in the same commodity. Only when we have wandered observantly off the beaten tracks and listened to the chance scraps of conversation among the country-folk in the summer months, and heard most of it bearing on the state of the crops and the probable prices ahead, can we appreciate what the precious grain means, even in these days of growing industrialism, to the people of Japan. Japan is not only the third most important rice-producing country in the world, but its rice in quality stands first. In its cultivation all is carried out according to the strictest rule, with a conservatism born of experience. The sowing, for instance, *must* take place on the eighty-eighth day of spring, the first day of which is also New Year's Day. Before sowing the seed is soaked in salt water for a week, washed in fresh water, and then dried,



AN OLD-FASHIONED PEASANT ABOUT TO LOAD HIS OX WITH LIGHT TIMBER.
Note the ancient fashion of hair-dressing with the "top-knot."

after which it is planted in well-watered " nursery " beds. About the end of May it is transplanted into " paddy-fields " in small bunches about a foot apart, an operation employing literally almost millions of


HARVEST-TIME IN THE HILLS.

men and women knee-deep in water and mud. This is an occasion of great rejoicing, and is celebrated with special songs known as *ta-ue-uta*—" rice-field planting songs." The most momentous period of the whole year, however, comes at the end of August or the beginning of September, when the *ni-hyaku-toka*—the " two hundred and tenth day "—draws near, for it is the ten days which then follow that form the season of intensest anxiety, of mingled hopes and fears, through which the bulk of the population of Japan passes from year to year. The rice is then ripening fast, and it is a gentle breeze that is urgently needed, although it is just at that precise moment that there is usually the gravest peril threatening, in the dreaded typhoon, which not only marks the break-up of summer, but incidentally the breaking-up of much else ! With the ripening of the various crops in their proper seasons, and with the birds and countless varieties of insects in which Japan so abounds eager to prey on them, the fields are dotted over with little flags of bamboo and paper inscribed with charms against their depredations. These are called *mushi-yoke*—" vermin dispellers "—and are bought at shrines of repute all over the country.

Next in importance to rice come the silk and tea industries, which furnish revenues of some 20 and nearly 5 million pounds sterling respectively, silk being produced mainly in central, and tea in central and southern Japan. There are many features of peculiar interest connected with the cultivation of silk, of which not the least is the treatment of the precious worm itself. It is popularly called *O ko sama*—" the honourable little gentleman "—and during the period of its " intensive cultivation," mainly the month of August, the satisfaction of its voracious appetite keeps whole households occupied day and night, to the exclusion of all else. The leaf-strewn trays, arranged in tiers, fill nearly every room in the house, and the sound of the ceaseless nibbling of the countless myriads is precisely that of the scratching of a thousand pens in the Cambridge University Senate House on an examination day. It is believed that any harsh or noisy, ill-bred conduct on the part of persons within earshot of the little creatures will seriously affect the quality of the silk produced.

Of tea, the national beverage of Japan (drunk always without sugar or milk), we cannot speak in detail. Like most good things in Japan, it was introduced from China about A.D. 800, and for 1,000 years its use was almost confined to the aristocracy and the Court. It is picked after three years' growth of the plant, and is nearly all consumed in the country, with the exception of some fifty million pounds exported to Canada and the United States.

Mention should not be omitted of the part played by the policeman of the country-side as guide, philosopher and friend to all who meet him there on his often lonely beat. Some years ago he was instructed to impress on the good rustics, in their intercourse with European travellers, the following cautions (the unconscious humour lurking therein suggests the person responsible for drafting them did so somewhat feelingly) :

" No criticism should be made, either by gesture or words, regarding the language, attire, or actions of foreigners.

" Foreigners are most sensitive regarding cruelty to animals, therefore special attention should be given to this matter.

" When a foreigner pulls out his watch *and looks at it,* you should think that he has business elsewhere, and that it is time for you to leave.

"It is a mistake to suppose that a foreigner will always respond to an application for a loan of money."

On one of my earliest expeditions in the Japanese Alps, I found myself sharing the shelter of a primitive hut with a little rural policeman, whose acquaintance I had made near the mountain foot. At night he insisted on sleeping on the floor beneath my hammock, which I had slung on a convenient beam in the roof. Yet, when I chanced to roll out and land on him somewhat heavily, as he lay snoring peacefully below, his sole comment on this sudden and violent interruption, instantaneously delivered on waking up, was but the politest of apologies—"*O jama wo itashimashita*"—"I am sorry to have been in your honourable way!"

Standards of Correctness in English[1]

By Henry Cecil Wyld, M.A.

Merton Professor of English Language and Literature in the University of Oxford

THOSE who are acquainted with the details of English pronunciation, and the grammar of colloquial speech among good speakers, during the 17th century and the first half, at any rate, of the 18th, cannot fail to be struck by the free and easy character of this period compared with our own day.

The difference may be briefly summed up by saying that at the present time, most speakers who have at least the pretension of elegance and correctness, are, consciously or unconsciously, considerably influenced by the traditional spelling of words, whereas the men and women of the days of Charles II, James II, William III, and Queen Anne did not trouble themselves much about spelling, and certainly did not allow this to influence their speech.

The standard of politeness in uttered speech in the 17th and early 18th century was the traditional practice current in good society, and it is hardly conceivable that anyone in that age whose English would pass muster in what Lord Chesterfield called the 'best companies,' should ever have laid down the law on such matters, as we sometimes hear it done to-day, by saying, "We spell in such and such a way, therefore we ought to pronounce thus or thus." There was, it is true, no lack of learned pedants in the 17th century, especially in the earlier part of it, who applied such tests and recommended people to speak according to their theories of what ought to be, but I cannot find that anyone paid the slightest attention to such vagaries.

It was not until about the middle of the 18th century, so far as I can discover, that there was a serious reaction against the prevailing habits of what we should now consider slipshod, careless, or even vulgar speech.

This reaction was very largely due to the influence of Dr. Johnson, which was exerted *directly* over a wide and distinguished social circle, and *indirectly* through his Dictionary, which was published in 1755. Certain remarks in this great work gave an authoritative sanction to the small fry of teachers of elocution and obscure writers on the art of good spelling. Henceforth, down to our own time, the process of 'correcting' well-established pronunciations is still going on. Each generation of school teachers sweeps away something of traditional speech and puts something new and strange in its place. It is an interesting fact that these new pronunciations, made according to the supposed intention of the spelling, the history of which is rarely known to the reformers, often gain a footing in circles where a few years ago such things would have been accounted ignorant vulgarisms associated only with the half-educated.

I may mention a few at haphazard that have penetrated during my own lifetime far beyond the sphere of influence of the Primary School. The following are all strange to me and still give me something of a shock: *humour, humorous* pronounced with an initial aspirate; *waistcoat* pronounced like *waist* and *coat*; *Marylebone* pronounced in three syllables with the first element like the name *Mary*, the *le*, and then the last syllable like the word *bone*; *Pall Mall* with both parts rhyming with *shall*; *landscape* with the second syllable rhyming with *shape*; *often* with a *t* in the middle (though we know that as far back as the 16th century Queen Elizabeth omitted it!); *Cirencester* with the first part like *syren* (though 500 years ago *Sissister* or *Sisseter* was established); the suffix *-ham* in place-names like *Birmingham*, etc., often pronounced with an initial *h-*; (does any one pronounce *h* in *exhaust* and *exhibit*, I wonder?); *southern* with the vowel of the first syllable like that in *south*; *Wednesday* with a *d* in the middle (though it had been lost in natural pronunciation at least as early as the 15th century!). Such are a few of the novel pronunciations which occur to me. None of these things were typical of good English in the past; some of them are still regarded as very vulgar; others may be heard from speakers whose English is in other respects free from the vulgarism of sham refinement. This shows that a style of pronunciation, based solely upon spelling, and with no justification from traditional usage, is coming in more and more. The efforts of

[1] For further reading in this subject the author's recent book, *A History of Modern Colloquial English* (T. Fisher Unwin, 21s.), may be consulted.—ED.

schoolmasters to break with tradition and to substitute something which they consider superior have been crowned with no small success in the past, and it seems unlikely that they will be less successful in the future. Very soon English will have lost most of its ancient and reputable traditional pronunciation, and be little else than a modern concoction with nothing behind it. This process of re-creation is being carried out in the name of 'correctness,' of clearness, of reverence for the history of the language (which, as a matter of fact, it sets at nought), upon any and every pretext which suits the taste of the innovators.

It is my intention to set forth some of the ways in which the colloquial English commonly accepted as polite to-day, differs from that of the great age of Dryden, Congreve, Pope, and Swift. Many of the actual words chosen as examples can be shown to have been pronounced as will be indicated several centuries earlier, but I shall, as a rule, confine myself to establishing the pronunciation current among the refined and polite in the 17th and 18th centuries.

It will be seen that our present-day pronunciation, where it differs from that of this earlier period, is due to an attempt to follow the spelling.

It is fair to Dr. Johnson to quote his own words on pronunciation which have already been referred to. There is no evidence known to me that this great man, either in his practice or in his precepts, would have supported the complete break with tradition which has come about since his day. On the contrary, we know that he was careful to ascertain what was the prevalent custom with regard to words about which there was any doubt. Further, had Johnson himself habitually adopted any fantastical or pedantic modes of pronunciation, we should hardly have been left uninformed of them by Boswell.[1]

This is what Johnson says about English pronunciation: "Most writers of English Grammars have given long tables of words pronounced otherwise than they are written, and seem not sufficiently to have considered that of English, as of all living tongues, there is a double pronunciation, one cursory and colloquial, the other regular and solemn. The cursory pronunciation is always vague and uncertain, being made different in different mouths, by negligence, unskilfulness, and affectation. The solemn pronunciation, though by no means immutable and permanent, is yet always less remote from the orthography, and less liable to capricious innovation."

[1] As a matter of fact Boswell mentions that the people of Lichfield, who, Johnson declared, spoke the purest English, pronounced *there* so as to rhyme with *fear* instead of with *fair*, and *once* as "*woonse* instead of *wunse* or *wonse*." He adds: "Johnson himself never got entirely free of these provincial accents."

"For pronunciation the best general rule is, to consider those the most elegant speakers who deviate least from the written words."

Here we have a very temperate and pregnant statement. It will be noted that Johnson refers to the 'solemn' pronunciation as 'less liable to capricious innovation' than the 'colloquial.' Could he have foreseen the length to which those who came after him would go in the direction of innovation, we may well doubt whether he would not have qualified somewhat his rule whereby the most elegant speakers might be recognised.

(*To be continued and concluded in the October number.*)

BIBLIOGRAPHY

(References will be made to this in the further instalment of the article.)

Paston Letters. (Constable & Co., Ltd.)
Cely Papers. (Camden Society.)
Queen Elizabeth's Letters to James VI. (Camden Society.)
Gregory's Chronicle. (Camden Society.)
Bishop Latimer's Sermons. (Arber Reprints, Constable & Co., Ltd.)
Machyn's Diary. (Camden Society.)
Memoirs of the Verney Family. Four vols. (Longmans, Green & Co., Ltd.)
Correspondence of Dr. and Mrs. Basire. (John Murray, 1831.)
Wentworth Papers. Ed. Cartwright. (Wyman & Sons, 1883.)

The Life-History of the Stars

By the Rev. Hector Macpherson, M.A., F.R.A.S., F.R.S.E.

THE idea of evolution in connection with the stars dates only from the beginning of the nineteenth century. Sagacious guesses as regards the origin of the universe had, of course, been made from time to time; and Kent in the middle, and Laplace at the close, of the eighteenth century, had outlined theoretically the possible course of development through which our own Solar System had passed. But it was not until the beginning of the ninteenth century that Herschel, as a result of his long-continued study of the nebulæ, familiarised the scientific world with the idea that stars had developed in the course of ages from matter in a nebulous state.

In his paper read before the Royal Society in 1811 Herschel gave a list of all the nebulæ which he had discovered and studied, "assorting them into as many classes as will be required to produce the most gradual affinity between the individuals contained in any one class with those contained in that which precedes and that which follows it." He traced a probable evolu-

tionary sequence from extensive diffused nebulosities through irregular nebulæ, " nebulæ a little brighter in the middle " and " much brighter in the middle," to planetary nebulæ and nebulæ " nearly approaching to the appearance of stars." He expressed the view that " every succeeding stage of the nebulous matter is the result of the action of gravitation upon it while in a foregoing one, and by such steps the successive condensation of it has been brought up to the planetary condition. From this the transit to the stellar form requires but a very small additional condensation of the nebulous matter." Herschel's nebular theory, which seemed for a time to have been refuted by the resolution of many nebulæ into closely-compressed clusters of stars, was triumphantly vindicated by the dramatic discovery made by the late Sir William Huggins in 1864. In that year the newly-invented spectroscope revealed to Huggins the actual existence of the " shining fluid " which many had been inclined to dismiss as a figment of Herschel's imagination. And with the detection of genuinely gaseous nebulæ, the concept of stellar evolution was finally rehabilitated.

The reinforcement of the telescope by the spectroscope enabled the later nineteenth-century astronomers to do what had been beyond the power of Herschel—to classify the stars according to their physical condition. Secchi, the Italian astronomer, made in the sixties his epoch-making survey of the spectra of the brighter stars, as a result of which he divided them into four general types—white stars, yellow stars, and two classes of red stars. At first this classification was regarded as more or less empirical and arbitrary, but latterly Secchi came to the view that it " represented real physical conditions varied by the temperatures prevailing on the different stars." In 1865 the German astronomer Zöllner, of Leipzig, casually suggested that yellow and red stars were simply white stars in different stages of cooling, and this idea formed the basis of the elaborate classification of the stars which we owe to his distinguished pupil Vogel, afterwards of Potsdam. " A rational classification of the stars according to their spectra," Vogel wrote in 1874, " is probably only to be obtained by proceeding from the standpoint that the phase of development of the particular body is in general mirrored in its spectrum." Vogel retained the general framework of Secchi's classification, holding that the white stars, such as Sirius and Rigel, were the hottest and youngest stars, yellow stars such as the Sun and Capella being obviously older and cooler. He viewed the red stars as still older and much cooler, as " effete suns hastening rapidly down the road to final extinction." Vogel revised his classification in 1895, in order to make room for the newly-discovered group of blue or helium stars, which he considered to be still hotter and more immature than the suns of the Sirian variety. In the main, Vogel's scheme and its underlying evolutionary assumption was adopted by Huggins, and formed the basis of the elaborate " Draper classification," carried through at Harvard, U.S.A., under the direction of the late Professor E. C. Pickering. This classification is based on the observed spectral lines, and is at the present time in general use. In this scheme, the various classes of stars are designated by the letters OBAFGKMN—types O, B, and A corresponding roughly to the Sirian type, F, G, and K to the solar type, and M and N to the two classes of red stars. This sequence, OBAFGKMN, was, until about ten years ago, believed by the great majority of astronomers to represent the order of stellar evolution. The association of the early-type stars with nebulæ was strongly confirmatory of this assumption. In 1910 came the discovery, independently announced by Professor Kapteyn, of Groningen, and Professor Campbell, of the Lick Observatory, that the average radial velocities of stars of the later types were greater than those of the earlier types. This was believed to be the final confirmation of the Harvard order of evolution.

There had been, however, grave doubts in certain quarters as to the accuracy of the generally accepted theory. Ritter, of Aix-la-Chapelle, for instance, had regarded the red stars as composed of two separate groups, stars increasing and stars decreasing in temperature. This view was adopted by the late Sir Norman Lockyer, who placed stars of Secchi's third type on the ascending scale, and stars of the fourth on the descending. He also recognised two groups of solar stars, and looked on the white stars not as the youngest orbs, but as stars in their prime. Lockyer's views met with little acceptance at the time, probably because of their association with his meteoritic hypothesis of cosmogony. It was not until the beginning of the present century that serious doubts began to enter the minds of most astronomers. At length, in 1912, Mr. R. T. A. Innes, the director of the Union Observatory in Johannesburg, suggested that the true evolutionary order is the reverse of the Harvard sequence.

In 1905 Hertzsprung, of Potsdam, pointed out that the stars appeared to belong to one or other of two well-defined classes—large diffuse stars and comparatively small stars of greater density. To these two classes he gave the names of " giants " and " dwarfs." This discovery was made independently by Professor H. N. Russell, now director of the Princeton Observatory, New Jersey. From data concerning the masses and brightness of the stars compiled in the course of investigations of stellar parallax, Russell recognised the existence of giants and dwarfs among the red stars. " There are," he wrote in December 1913, " two great classes of stars—the one of great brightness averaging,

perhaps, a hundred times as bright as the Sun, and varying little in brightness from one class of spectrum to another; the other of smaller brightness, which falls off rapidly with increasing redness."

Obviously the existence of these two types of stars was difficult to account for on the generally accepted theory of stellar evolution; it seemed remarkable that there should be some red stars large and diffuse and others small and dense, if all red stars were to be regarded as "effete suns hastening rapidly down the road to final extinction," as Vogel believed. Later came Dr. Harlow Shapley's work on eclipsing binary stars. His investigations brought out the surprising result that some stars of the second or solar type were less dense than some stars of the first. Manifestly this result contradicted the accepted hypothesis on which all second-type stars were considered to be older, and therefore denser, than stars of the first class.

Accordingly, Professor Russell was driven to put forward a new theory, or, rather, to revive Lockyer's hypothesis, considerably modified. "The order of increasing density," said Russell, "is the order of advancing evolution. . . . The giant stars, then, represent successive changes in the heating up of a body and must be more primitive the redder they are; the dwarf stars represent successive stages in its later cooling, and the redder of these are the furthest advanced." The sequence of evolution, then, begins and ends with Class M, and Class B—the helium type—occupies the middle place. The B or helium stars are on the crest of the evolutionary curve, at the meridian of stellar life.

Thus, on Russell's theory, a star in its earlier stages is of great volume, and comparatively low temperature —about 3,000° C.—and its density is almost incredibly low —$\frac{1}{25,000}$ of the density of the Sun. As the star contracts, it grows hotter and denser. The brightness, however, remains more or less constant, the shrinking area being just about compensated for by the increasing surface-brightness. This process of contraction, accompanied by increase of temperature, goes on until the star reaches the B stage, when its temperature is about 20,000° C. and it shines with a blue light. After this stage is reached and the star attains a certain density, it falls off rapidly in temperature, and becomes a cooling dwarf. It is at first a star of the Sirian and next of the Solar type, and then finally is transformed into a feebly luminous star. According to this theory, then, our Sun is a fairly large dwarf star, of decreasing brightness and temperature.

In putting forward his hypothesis, Professor Russell pointed out that the relative scarcity of the B stars—the giants of maximum temperature—is to be accounted for by the fact that only stars of very large mass are able to attain to the high temperature of the B type stars. "Only these stars would pass through the whole series of the spectral classes from M to B and back again in the course of their evolution. Less massive bodies would not reach a higher temperature than that corresponding to a spectrum of Class A, those still less massive would not get above Class F, and so on." "It is now easy to understand why there is no evidence of the existence of luminous stars of mass less then one-tenth that of the Sun. Smaller bodies presumably do not rise, at maximum, to a temperature high enough to enable them to shine perceptibly from the stellar standpoint, and hence we do not see them. The fact that Jupiter and Saturn are dark, though of a density comparable to that of many of the dwarf stars, confirms this view."

When the theory was first promulgated, the difficulties in the way of its acceptance seemed insuperable. In 1915 Professor Eddington pointed out that "it plays havoc with a great deal that has hitherto seemed orderly and intelligible," and he specified the progression of average velocity from the earlier to the later types. This objection, however, has not the force which it possessed six years ago. The work of Eddington himself, and of Kapteyn, Adams, and others indicates that the increase of velocity with spectral type is simply a particular manifestation of a wider generalisation, namely, the increase of speed with diminishing absolute magnitude, and probably, therefore, with mass. Russell's words in 1914 have certainly been justified by the progress of research: "A correlation of mass and velocity . . . seems more probable than one between temperature and velocity, or velocity and age."

Perhaps no new hypothesis in the whole history of astronomical science has been so signally and decisively confirmed within a few years as the evolutionary theory of Professor Russell. First of all, the work of Hertzsprung indicated that even among the "early types" two classes of stars were probably to be distinguished. Striking confirmation was obtained by Dr. W. S. Adams in the course of his determinations of stellar parallaxes by the new spectroscopic method at Mount Wilson Observatory. In 1916 Adams announced that "two groups of M stars are indicated clearly by an examination of the intensities of the hydrogen lines: in the first the hydrogen lines are very strong; in the second they are very faint. . . . Connecting links over a range of seven magnitudes are entirely lacking." At the same observatory, Dr. Harlow Shapley, now of Harvard, discovered in the distant star-clusters red and yellow stars which, to be visible at such vast distances from our system, must be giants. He also noticed that in some of the clusters the brightest stars were red, a result which is explicable only on Russell's theory.

Perhaps the most striking of all the pieces of evidence

is the information which had been gained as to the actual sizes of certain stars during the past few years. In 1916 two very faint stars of rapid proper motion were discovered, one by Professor Barnard at the Yerkes Observatory, and the other by Mr. Innes in South Africa. The small star in Ophiuchus detected by Barnard proved to be one of the Sun's nearer neighbours in space, its parallax being easily measurable. The luminosity of this small red star appears to be only $\frac{1}{2,000}$ of that of the Sun, and its diameter three-ninths. Mr. Innes' star—still nearer to our system—appears to be about the same luminosity and size. "It is," Dr. A. D. C. Crommelin has pointed out, "in all probability very near the end of its career as a star, and an opaque crust may be expected to form over its surface comparatively soon." These stars, then, are indisputably dwarfs.

A still more striking piece of confirmatory evidence was obtained in December of last year. In the course of his address at the British Association in August 1920, Professor Eddington, adopting the theory of Professor Russell, made an estimate of the probable angular diameters[1] of some of the brighter stars. "The star with the greatest apparent diameter is almost certainly Betelgeux, diameter 0·051." On the night of December 13, Messrs. Pease and Anderson succeeded in measuring the diameter of this star by means of the new interferometer attached to the great 100-inch reflector. The angular diameter of Betelgeux—the first stellar diameter ever directly measured—came out at 0·045. The parallax is known with some degree of accuracy, and from this the actual size of the star can be computed. The diameter appears to be not less than 273,000,000 miles, and the volume about 27,000,000 times that of the Sun. The existence of giant stars is, therefore, no longer a matter of theory; and Professor Russell's hypothesis has been triumphantly vindicated by observation. More recently the diameter of Arcturus has been measured. The angular diameter is 0·012, in close accord with Eddington's estimate; and the linear diameter is about 19,000,000 miles, just its theoretical size according to the theory of Russell.

In presenting the Gold Medal of the Royal Astronomical Society to Professor Russell, in February 1921, Professor Alfred Fowler remarked that the theory "has the great merit of simplicity and it violates no known physical laws. Russell has led us step by step from the simple conception of giant stars to a consistent explanation of a multitude of phenomena, so that the scope of the theory has become almost as wide as the universe itself." This is eminently true, yet the hypothesis, while solving a multitude of problems, has opened, or rather reopened, several others. What, it may be asked, are the place and function of the nebulæ according to this outline of the sequence of the stellar evolution? Russell's theory begins with the great diffuse red giants, and this stage he takes to be the earliest stage in stellar life. It so happens that the nebulæ, which since Herschel's time have been almost universally regarded as the primeval world-stuff, are usually to be seen in association with white and blue, not red, stars. In the decisive words of Professor Campbell, "Nebulæ and red stars do not coexist. . . . If you find a red or yellow star of normal type, do not look for a nebula in apparent contact with it." The problem is still further complicated by the fact that the Wolf-Rayet stars, a rare class akin to the B stars, are closely related to nebulæ, and that in many cases the nuclei of planetary nebulæ are actually Wolf-Rayet stars. Many temporary stars, too, in the later stages of their history pass through a nebular and then a Wolf-Rayet stage.

Professor Russell would seem to incline to the view that the irregular gaseous nebulæ are not the progenitors, but the products, of the hot B type stars. It may be that these intensely hot gaseous masses, expelled from the stars at their period of greatest heat and activity, ultimately develop into planetary systems, but if Professor Russell's theory is the true one, they are not the parents of stars. The stars would appear to be vastly older than the gaseous nebulæ. Recent investigation has, however, indicated the existence of vast masses of dark nebulosity, particularly in the vicinity of the galactic zone. This dark nebulous material was first disclosed by the photographs of Professor Max Wolf; and latterly Professor Barnard has discovered a large number of these "dark patches" and has, indeed, compiled a catalogue of them. Apparently, if Russell's theory be the true one, these dark nebulæ and not the bright, glowing gaseous masses, such as that in Orion, constitute the primeval chaos from which the stars are born.

Another problem which has not yet been fully solved is the place occupied by temporary stars in the scheme of things. Time was when the appearance of a new star was a rare phenomenon. A hundred years ago, only about half a dozen authentic instances of the appearance of new stars had been recorded in the course of astronomical history. Within recent years, however, owing to the closer watch kept on the heavens, and the large number of celestial photographs which are secured at the different observatories, many of these "novæ" are now known to have appeared, and several are usually detected in the course of a single year. The spectroscopic study of the brighter members of this class has shown that, after the initial outburst which gives rise to a temporary star, a certain sequence is usually followed. After the appearance of a bright-

[1] The angle (in seconds) which the diameter subtends at the earth

line spectrum, the lines characteristic of nebulæ come into prominence. The new star, in fact, appears to be transformed into a nebula in the later stages of its decline; while, at a still later stage, the spectrum becomes similar to that of the Wolf-Rayet stars. Thus, in 1902, Pickering found the spectrum of Nova Persei to be nebular; five years later, Hartmann at Göttingen discovered that the spectrum was essentially identical with that of a Wolf-Rayet star. Some years ago, the spectra of four novæ were closely studied by Messrs. Adams and Pease at Mount Wilson. By July 1914 they noticed that the two oldest, Nova Aurigæ and Nova Persei, had become Wolf-Rayet stars, and by April 1915 Nova Lacertæ and Novæ Geminorum had become similarly transformed. In connection with this discovery Adams and Pease remarked that "this identity of spectrum, taken in connection with the well-known agreement of distribution, relative to the Milky Way, of novæ and Wolf-Rayet stars, makes it probable that at least a portion of the latter are Wolf-Rayet stars in the later stages of their history."

The recent work of Mr. Van Maanen, the distinguished Dutch astronomer, has shown that a number of the Wolf-Rayet stars which form the nuclei of planetary nebulæ are of feeble absolute magnitude and, therefore, presumably of small mass. This fact is difficult to reconcile with the order of stellar evolution as sketched by Russell, and would suggest that there is an alternative path of evolution, and that some, at least, of the dwarf stars, especially those abnormal stars of which a few have been found in recent years, have developed out of planetary nebulæ, which in their turn have been the products of celestial catastrophes, either of collisions between two or three feebly luminous stars, or of encounters of stars with nebulous matter. Russell's hypothesis, however, accounts for the physical condition, brightness, volume, and mass of the overwhelming majority of the stellar bodies, and at present holds the field against all other cosmogonic theories.

What of the time-scale of stellar evolution? The periods of time required for the stars to pass through their various stages appear to be so enormous that in trying to conceive them—to quote Horace Walpole's dictum in regard to the work of Herschel—"one's imagination cracks." Dr. Shapley's study of the stars in the nearer clusters, 20,000 light-years [1] away, and those in the most distant systems, 220,000 light-years removed from our earth, has shown that the stars in the one cluster seem to be at the same stage of development as the stars in the other, which indicates that 200,000 years is a negligible quantity in the life of a star—a mere tick of the clock. Recent studies of stellar evolution abundantly confirm the geological estimates of the vast age of the earth. Periods of thousands of millions of years are not extravagant estimates of the age of our own world. What, then, must be the age of the Sun? How many tens or hundreds of thousands of millions of years have elapsed since the Sun was a red giant, flickering feebly for the first time out of the dim night of the primeval chaos?

[1] A light-year is the distance travelled by light in one year. About 5,860,000,000,000 miles.

BIBLIOGRAPHY

Sir William Herschel: *Collected Scientific Papers.*
Sir William Huggins: *Scientific Papers.*
A. S. Eddington: *Stellar Movements and the Structure of the Universe.*
H. N. Russell: "The Spectra and other Characteristics of the Stars." (*Popular Astronomy*, vol. xxii.)
H. Shapley: "Studies based on Colours and Magnitudes in Stellar Clusters." (*Mount Wilson Contribution*, No. 167.)
A. Fowler: Presidential Address to R.A.S., in *Monthly Notices*, vol. lxxxi, No. 4.

The Roman Calendar

By W. R. Halliday, B.A., B.Litt.
Professor of Ancient History in the University of Liverpool

It is, curiously, seldom that familiar words in ordinary use convey the associations of their literal meaning, and while many readers are probably aware, if they stop to consider it, that September means "the seventh month," few probably have noticed the anomaly of calling the ninth month of the year by this name.

The calendar month is, of course, part of the heritage bequeathed by the Roman Empire to European civilisation. At first sight, however, the problem is no nearer solution, for the Roman Empire, too, began its official year upon January the first. Earlier, when Rome was still a republic, at any rate after 153 B.C., it was upon the first of January that the two consuls, the annually appointed magistrates who constituted the chief executive of the State, entered upon their duties. But as the names of our months still testify, the Roman year had originally begun in March, the month of spring, "when winter's rains and ruins are over," when the citizen-farmer looked forward to the agricultural prospects of the year, and the State to the needs of the summer campaign. Appropriately this is the month of Mars, who was both the god of husbandry and the god of war. There follow April, "the month in which things open," May, "the month of growing," and June, "the month of ripening." July and August owe their present names to Julius Cæsar and Augustus; originally they were called Quintilis, the fifth, and Sextilis, the sixth month respectively. September, October, November, and December are similarly numerical names. January, when the days

begin to lengthen and the sun, after the winter solstice, enters upon a new course, takes its name from Janus, the god of doors or openings. Februum means an instrument of purification, and February, the last month of the year, is the month of expiation and purification, the Lent of the Roman year. The purpose with which the calendar was first formulated was a religious one. Throughout their history the Romans displayed a very strong legal sense, and this trait is markedly present in their religious conceptions, which are of a contractual character. The early Roman believed that the divine powers would treat him in exact requital of his treatment of them. If he rendered them their due at the right time and in the right manner, they would be bound to repay him with the appropriate blessing. On the other hand, any sin of commission or omission, whether due to accident or design, would inevitably have disastrous results for him and for the community to which he belonged. It was therefore of the first importance, both for the State and for its individual members, that the spiritual experts, the aristocratic college of *pontifices* who administered religious law, should make it known upon what days religious acts should be performed, and upon what days it was permissible or not to transact the ordinary business of life without offence to the divine powers.

In constructing their calendar, the experts had a difficult task. Anyone who has interested himself in vulgar superstition or in the beliefs of the backward races will realise that the most obvious division of time longer than the day is provided by the lunar month. It is easily to be observed and calculated, and with its periodicity the recurrence of various remarkable physiological and natural phenomena corresponds. But while the lunar month is an obvious starting-point, most inconveniently it refuses to harmonise with the solar year. For a people, however, whose interests were primarily agricultural and pastoral, the observance of the solar seasons was essential. Clearly a system would not work if in time it might involve the religious rites appropriate for sowing being performed at a date when actually the harvest was being garnered. The earlier calendar at Rome, which consisted of 355 days divided into 12 lunar months, in fact proved unworkable because it thus fell out of harmony with the seasons. In 450 B.C. the Romans therefore adopted a Greek system which worked by a cycle of four years. Of these the first and third remained at 355 days, to the second were added 22 days and to the fourth 23 days. In each case the additional days were inserted after February 23. This was a good deal better than the old system. Instead of falling annually short of the solar year by $10\frac{1}{4}$ days, the calendar was now 4 days in excess every four years. There was still, however, this discrepancy which was arbitrarily adjusted from time to time by the priestly college, who increased the confusion by abusing their power of proclaiming an addition to the number of days in the year for the political purposes of the moment. The question of adding days to the year was, in fact, decided not by the needs of the calendar, but upon such considerations as whether the political wire-pullers wished to postpone an event or to protract the tenure of office of a particular individual by the additional days.[1] The result was naturally chaos, and, when Julius Cæsar took the calendar in hand, it had lost all relation to the seasons, and was more than two months out of the true reckoning. In 45 B.C. Julius adjusted the error and established the year of 365 days with an additional day every four years, the system which, with one further adjustment in Western Europe, is in force to-day.[2]

The schoolboy learns in his Latin grammar that Roman dates are determined by their relation to one of three fixed points in the month, viz. the Kalends, Nones, and Ides. Of these, he is told that the Kalends are the first of the month, that—

> " March, July, October, May,
> Make Nones the seventh, Ides the fifteenth day "—

and that in the other months the Nones fall upon the fifth and the Ides upon the thirteenth. These three fixed points represent the new moon, the first quarter and the full moon. Upon the Kalends the *pontifices* announced the date of the Nones for that month, and upon the Nones, the first quarter, the religious festivals for the month were publicly proclaimed. With one exception, there were no festivals between the Kalends and the Nones in any month.

A further small point may be noticed. The Romans considered that the odd numbers were lucky, and the even unlucky. In consequence religious festivals fall upon the odd days of the month. Where there is a consecutive group of festivals the even days are left blank between them, and even a single festival which lasts more than one day may be held, not concurrently, but upon every other day. For example, the Lemuria were celebrated upon the 9th, 11th, and 13th of May. Before the reformed calendar of Julius Cæsar, all the months with the exception of February, the unlucky month, contained an odd number of days.

[1] For an example reference may be made to Cicero's Letters, *Ad Fam*, viii. 6, of which a translation is given in Jean's *Life and Letters of Cicero*, No. 35. Cicero himself was interested, as the addition would have involved the prolongation of his provincial governorship, which he was far from desiring.

[2] The adjustment made in England, though not without some popular opposition, in A.D. 1725 corrected the existing error, and provided that the century years should not count as Leap Years. Eastern Europe has retained the Julian calendar unaltered.

Originally the knowledge of the calendar, like that of all religious law, was the monopoly of the aristocratic college of priests, but inevitably, in course of time, announcement was supplemented by publication. In 304 B.C. for the first time the calendar was exhibited in the market-place, and in 189 B.C. one of the consuls adorned the temple of Hercules and the Muses with a permanent record of the dates of the regular festivals. After the adjustment of Julius Cæsar, the reformed calendar was copied and set up in Rome and elsewhere, and thanks to the survival of a number of fragments of these inscriptions, we possess the Roman calendar practically complete.

This document, though itself of imperial date, throws the most valuable light upon the early Roman religion. As Rome became a cosmopolitan city, Roman religion had been permeated with foreign influences. Roman mythology, like Roman literature, was Greek in origin, and in the literary sources for the study of Roman religion it is often impossible to disentangle what is genuinely Roman. But thanks to the conservatism of Roman official documents, these inscriptions enable us to recover the general outline of the public worship of early Rome with absolute certainty. For in these calendars the old native festivals are written in large capitals, and so distinguished from the later accretions to the ceremonies of the religious year. The information given by the calendar is, of course, similar to that originally proclaimed each month by the religious authorities. It enables the ordinary man to know when, without offence, he may proceed with political or other secular business, and upon what dates he should perform religious duties. The first column divides the days into the purely secular week of eight days from market-day to market-day.

Although market-days provided schoolboys with a holiday, they appear to have had no religious significance. In another column, against each day is set a symbol to show whether religious law allowed the meeting of political assemblies or the transaction of ordinary secular business. Most of the older religious festivals involved complete abstinence from secular business, particularly those which were concerned with the dead or the powers of earth. There were a few cases where the day was divided between religion and business, and affairs might be transacted when the religious ceremonies had finished. There were other days which, for various reasons, were "unlucky." Out of the 365 days, 239 were marked as available for the transaction of secular business; upon the remaining 126 it was wholly or partially prohibited. Further, as we have already noticed, the calendars set out the major festivals of the early Republic in large capitals, while minor festivals, movable feasts, festivals which had been adopted by Rome under foreign influences, and, in some examples, valuable explanatory notes, are inscribed in a smaller lettering.

The nature of the older festivals brings us back to our starting-point, the religious calendar of a people interested primarily in agriculture and flocks and herds, which begins in March and ends with February, the month to which we still add the extra day in Leap Years. The break in the religious ceremonies is between those of February, which look backwards to the past year and its dead, and those of March, which look forward to the promise of the coming year. Throughout the year the festivals reflect the seasonal preoccupations of the farmer. The god of March represented the quickening power of spring, first manifest in his month. The leaping dance of his armed priests has been explained as a magical leaping to make the crops grow high. The clashing of their shields and spears which accompanied the dance may have served the double purpose of frightening away evil influences and of thunder-making by sympathetic magic. March, too, marks the opening of the campaigning season, when the arms and military trumpets were ceremonially purified against their coming use. Early in April a sacrifice of pregnant cows took place. Their calves were burned and the ashes used for fertility "medicine" in the shepherd's festival, which fell a few days later. In this month, too, sacrifices were performed to keep the mildew from the crop. May was marked by a festival of placation of the possibly malevolent ghosts of the dead, and in every household the father "redeemed" the family with black beans, which he spat out of his mouth nine times without looking back, and sent to their place such ghosts as were haunting the house. In May, too, certain human images made of wickerwork were cast into the river, a magical rite the object of which was probably to provide sufficient rain for the crops. And in this month took place the Ambarvalia, the festival which was perpetuated by the Catholic Church in the Rogation processions, and which still survives in some parishes in England in the yearly "beating of the bounds." The object, in the words of Cato's prayer, was to "keep, avert, and turn from us all disease, seen or unseen, all desolation, ruin, damage, and unseasonable influence; to give increase to the fruits, the corn, the vines, and the plantations, and to bring them to a prosperous issue." In June the Temple of Vesta, the sacred hearth and storehouse of the State, was purified; the agricultural significance of the ceremony was the purification and preparation of the storehouse against the harvest of the now ripening corn. July in Italy is a month of heat and drought. Two of the older festivals belonging to the month seem to have to do with deities of water, but their details are very obscure. In August the harvest was safely

in, and the month is marked by a series of harvest-home celebrations. September is unimportant from a religious point of view, but October concludes the agricultural process of the year with the ceremonial tasting of the new wine and the strange fertility-sacrifice of the October horse. The summer campaigning season, too, had now come to an end, and a purification of arms took place complementary to that of the beginning of the military year in March. November was a month of hard work, of ploughing and sowing, and with little leisure for religious festivals. December and January, however, brought the winter holidays of the farmer in the respite from toil before the labours of the spring sowing commenced. In December took place the Saturnalia, the forerunner of our Christmas celebrations, when friends exchanged presents and master and man joined in a common merry-making. The earlier half of January was marked by rustic festivals in the country, and in the city's calendar by the feast-day of a goddess of birth. February, as we have seen, was mainly given over to expiatory ritual and the worship of the dead.[1]

[1] A short but very good account of the calendar and of the development of Roman religion will be found in Mr. Bailey's recent edition of the *Third Book of the Fasti of Ovid*. A longer account is given in *The Roman Festivals of the Period of the Republic*, by the late W. Warde Fowler, the wisest and greatest Roman scholar of our time. His knowledge, which was wide and accurate, was informed by a rare insight and a real humanism. We shall not look upon his like again.

The three best books in English upon early Roman religion are Warde Fowler, *The Religious Experience of the Roman People* (Macmillan); Bailey, *The Religion of Ancient Rome* (Constable); and Carter, *The Religion of Numa* (Macmillan).

An Eighteenth-Century Character

By Rowlands Coldicott, M.C., B.Litt.

THE works of Dr. John Wolcot, once better known as "Peter Pindar," are almost forgotten, and the life of the man who wrote them is known only to a very fews But anyone who wishes to wander among the by-way of late eighteenth-century literature will find in the study of impudent Peter an excellent point of departure. Before he has gone far—such is the extraordinary endurance of the past—the present will begin to seem brittle and unreal, and actuality, leaving our much-trumpeted heroes of to-day, will set marching again those more solid people who fiddled and talked and rode and played in the days of George the Third, when modern life in England first began.

Our inquiry may well start with the publication of his first quarto pamphlet in verse. Examine it as it reappears on the next page, for it is something of a curiosity. So far as I know, no copy except mine exists, though perhaps someone will now jump up and refute me. The original issue of these verses "printed for the author" must have been very small. The label that bears the Latin quotation has been pasted over what was apparently in the first instance a misprint. Wolcot was a scholar, and could not tolerate mistakes. "It's poetry that soothes both gods above and spirits below," quotes Wolcot, and he proceeds to give men of the world between, not poetry, but comic verse. As an isolated phenomenon "The Epistle to the Reviewers" would not be remarkable, though it is the first set of verses that Wolcot wrote in what afterwards became his characteristic style; but as a solitary singing shell preluding a long bombardment it is of importance in the history of comic verse. In the third stanza Wolcot promises the public a succession of "Sonnets, Odes, and Legendary Tales" in terms that imply that his pockets were already full of them. Strangely enough, nothing happened for about four years, when a pamphlet appeared in London entitled "Lyric Odes to the Royal Academicians for MDCCLXXXII by Peter Pindar Esq^re^, A Distant Relation of the Poet of Thebes, and Laureate to the Academy." From that year till 1812, when a collected edition of his works was published in five volumes—all in verse and mostly comic—Pindar's "distant relation" never ceased publishing, and even then outgrew his own collected edition and went on and on, till finally at his death, in 1818, he left a chestful of unpublished manuscripts, many of which are scattered about the world in private collections, and have wandered even to New Zealand.

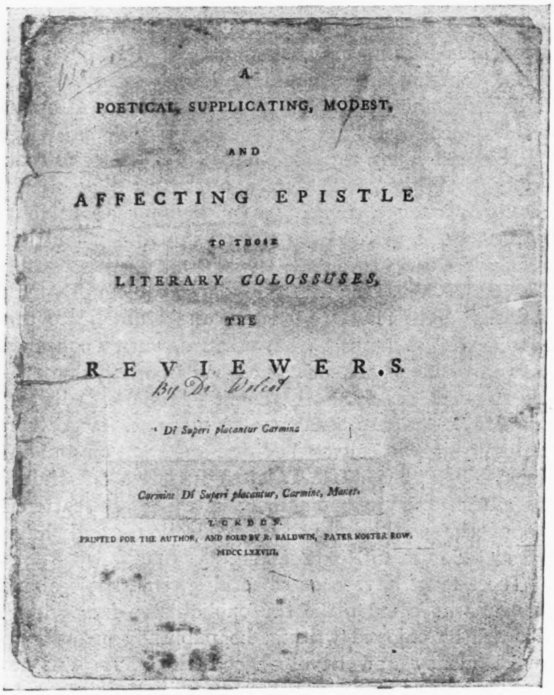
There must have been something remarkable about a man who could make the public listen for so long. Though he enjoyed writing, he published in order to make money and have a good time. He was no hypocrite, and made no bones about it:

> "Ladies, I keep a rhyme-shop; mine's a *trade*;
> I sell to old and young, to man and maid:
> All customers must be obliged; and no man
> Wishes more universally to please.
> I'd really crawl upon my hands and knees
> T'oblige; particularly, lovely Woman."

Towards the end of his life he said to his friend Taylor: "I was poor, and hunted in vain for Fortune in Europe, Africa, and the West Indies, but at last found her in a shop in Paternoster Row, laughing over my works and advising the booksellers to buy the copyright."

Wolcot made it pretty clear, too, in "The Epistle to the Reviewers," that he was out after commercial success. And yet, knowing the man, it is perfectly certain to me that what he loved far more was the free exercise of his undoubted powers in the presence of as

large an audience as he could collect. Ready as he was at the outset for any amount of success, he must have been surprised at the astonishing way his luck held and his reputation spread. It has been said—and there is truth in the remark—that, search where one will among the annals of the last years of the eighteenth century, one is certain sooner or later to run across the pseudonym "Peter Pindar." When Richard Twining, a quiet country gentleman, writes to Dr. Burney and mentions that he is reading Pindar, his sense of gravity allows him to add within a bracket "not Peter." When Miss Burney, in her official capacity at Court,



A

POETICAL, SUPPLICATING, MODEST,

AND

AFFECTING EPISTLE

TO THOSE

LITERARY COLOSSUSES,

THE

REVIEWERS.

By Dr Wolcot

Di Superi placantur Carmine

Carmine Di Superi placantur, Carmine, Manes.

LONDON.

PRINTED FOR THE AUTHOR, AND SOLD BY R. BALDWIN, PATER-NOSTER ROW.

MDCCLXXVIII.

TITLE-PAGE OF WOLCOT'S FIRST SATIRICAL PAMPHLET.

came for the first time into the presence of the King, her recollection of the wicked verses of Peter Pindar added to her confusion. There is a story that the Duke of Kent, travelling at that period in America, entered a cottage, and, seeing a girl with a book in her hand, inquired the extent of her reading. The girl replied, "Sir, the Bible and Peter Pindar!" That is too good a story not to be a story, but the evidence of his immense vogue over a long stretch of time remains. Burns says seriously in one of his letters that he will never be able to write as well as Peter Pindar. Byron of course read him, and took something more than a hint from him for his *Beppo*, the immediate precursor of *Don Juan*. Blake knew his works, and more than once refers to him. Porson the scholar wrote an epigram on him. His works were imitated widely and pirated. His style of verse tale was continued under the title of *Peter Pindarics* by James and Horace Smith, the famous authors of *Rejected Addresses*, in a volume entitled *Gaieties and Gravities*. In most scholarly works on the literature of the time—say 1782 to 1812—contemporary allusions are generally reinforced by footnotes containing extracts from Wolcot's pamphlets. But no one tells us much about the man.

If, as Pope said, the proper study of mankind is man, and not, as so many camp-followers of literature believe, the close hunting of tendencies and allusions, then the study of Wolcot himself is more to the point than close reading of his works. A more truthful answer is that the better the artist the more his works suffice, until he "all expresses" himself in them. Henry James develops this view in "The Death of the Lion." But Wolcot—to speak truth—was only occasionally a good artist; it is the history of the man himself, including his writings, that makes him so interesting a study. Few of his verses are of permanent worth, but almost all are very much more alive and provocative than nine-tenths of the lesser verse of his time. He attempts so much, so nearly "comes off" in so many directions, is so versatile and ambitious and voluminous that his readers are certain before long to want to know something more about this man with the writing itch and such a fund of energy. What was he like? How came he to write verse? A very full answer is forthcoming.

All early mentions of him agree that he was a heavy, unwieldy, clumsy boy, quick at repartee and fond of sarcastic jokes. The son of a country doctor who lived at Dodbrooke, in Devonshire, he was given an unusually good education, and at the age of seventeen went for a year to France. On his return he fell into that state of unrest and discontent often engendered in young people who have been "well educated" and then left in the lurch. By this time a benevolent uncle had taken him under his protection and set him to a seven years' apprenticeship in the family profession. Wolcot, who had commenced writing verse when at school, hated the work of an "apothecary," and divided his time between music, poetry, painting—and the young ladies of Fowey. The first published verses of his that can be traced appeared in 1756 in an obscure periodical called *Martin's Magazine*. They were addressed to a lady of great beauty and charm, a Miss Betsy Cranch. He proposed to her, and she accepted him—if he would wait his turn; she was four deep already! Next he transferred his affections to a Miss Chubb, and then to a Miss Coryton. But although he wooed with fury, and always enclosed verses in his letters, none of the ladies of Fowey would have him.

At length, at the close of the year 1762, Wolcot was sent to London to gain some experience of hospital practice. His stay there coincides with the rapid issue of the satires of Churchill. The resemblance between the two satirists is superficial, but both were vigorous and unscrupulous. Gifford, not Wolcot, was Churchill's descendant. Churchill wrote serious satire; Wolcot was always the jester.

Shortly after he arrived in town he stayed with a Mr. Giddy, who thus refers to him in a letter to a friend in Cornwall:

"Mr. John Wolcot, who now lodges with me, has very quick mental parts; but the component parts of his body are remarkably lazy and slow, except his fingers, which, applied to the fiddle or flute, move very nimbly. Entre-nous I am afraid he is too much acquainted with Shaftsbury and Voltair's notions."

He spent two years in London, and seems to have paid a visit to France again. So much is known of Wolcot's life that the gaps in our knowledge are very tantalising. For one gets an uneasy suspicion that there is much that has never been told. It is difficult to say whether he was a rascal or merely a bohemian. Many years later, when Miss Elizabeth Fry came to London, Wolcot was asked to "take her about," as the saying is. Yet he is represented as being an utter scoundrel, so disreputable that no decent lady would care to be in his society. Giffard's *Epistle to Peter Pindar* is the most ferocious attack ever made by one writer on another in the history of English verse. It goes so far that one's sympathy cleaves to Peter. Controversy at that time was waged in a style that makes milk and water of our modern feuds. Byron could not quarrel like Giffard: he used to forget himself into writing poetry. A comparison of *The Vision of Judgment* with *An Epistle of Peter Pindar*—both productions engendered by personal dislike—will reveal, as criticism never can, the untraversable space between mediocrity and genius.

In 1764 Wolcot returned to Fowey, and apparently began to practise as a doctor. The first thing he did was to write a passionate love letter to Miss Sukey Nankivell—who refused him. Here he is describing the opening of her reply:

"DEAR MISS NANKIVELL,

I have just received yours which remains yet unopened—now guess my sensations, all the blood up in my face, my ears tingling, my heart drumming against my ribs, and my spirits in an uproar! What a thin partition between me and despair, or supreme felicity. Fortune has hitherto turned her back on me, but let her now be kind and I will fairly forgive her all her former injurious treatment—A confounded jilt! She has murdered me!—To be plain I have opened your letter, am acquainted with its contents, and find my hopes blasted. . . ."

At this moment there came to Wolcot what appeared to be the opportunity of his life. Sir William Trelawney, with whom he had lately somehow become acquainted, suddenly received the governorship of Jamaica—a rich appointment. Wolcot, already sick of doctoring people at Fowey, immediately approached him, and asked to be taken out as physician to his household. Trelawney, seeing in Wolcot a lively and accomplished fellow of many parts, agreed to take him, provided he was properly qualified as a physician. Wolcot, who had no scruples and much push, managed to obtain immediately the degree of Doctor of Medicine from Aberdeen University, after a formal examination at Plymouth by a Dr. Huxam. On September 2 he writes to his friend Mr. Giddy:

"My friend Thomas has perhaps by this time been informed of my intended peregrination to a place characterised for being as hot as hell and as wicked as the devil. . . . The intent of my western expedition is undoubtedly to get money, for which beautiful acquisition I left friends, sweethearts and old England! . . ."

At the end of the year he writes from London, where he is going to be presented at Court. It is a very long letter full of interest:

"DEAR BENJY,

I am at length arrived in the great city, to prepare for the new farce in which I am shortly to make my appearance; my wigs, my hats, my swords, my canes, my laced cloathes, and last of all,—my chariot are all bespoke!"

He goes on to say that he expects to place himself "by the labour of a few years beyond the caprice of a mob." Afterwards he describes himself drest in white and gold, going in a sedan-chair to St. James's.

There are several letters of his about this time, written so vividly that they bring to us every detail of how he spent many hours of that gay year, waiting for his patron to set forth. At length he departs, and the next letter is from Teneriffe—a letter full of the beauties of Spanish ladies and the exceeding nastiness and number of the fleas there, which he never forgot, and to whom afterwards he wrote an ode. That his verses did not exaggerate the pest, present inhabitants of the town can testify.

Trelawney and his suite and his physician arrived at Jamaica in October 1768. At first all went well with Wolcot. "My time," he wrote, "passes away with the utmost cheerfulness." In fact he had nothing to do. Trelawney, on the other hand, found himself beset with difficulties. No one about him thought of anything but the getting of good "jobs," and a weak

predecessor had left the island in a state of violent disaffection. Amongst job-seekers Wolcot was *facile princeps*. At first he tried to get the appointment of "Governor of the Mosquito Territory." This scheme failed through the retirement at home of Shelburne, to whom Trelawney owed his present position. At last Trelawney told Wolcot that he could do nothing for him—unless he were in Holy Orders, in which event he could give him the living of St. Ann's, as the rector was very ill and could not live long. This with various fees could be made at that time to yield about two thousand pounds a year. As for the duties, to all intents and purposes they could be ignored. The clergy of Jamaica were, to put it in round terms, a pretty hot lot. Long, who was at this time Speaker of the Assembly, says that some were better qualified to be retailers of salt fish or boatswains or privateers than ministers of the gospel. To such a degree greed was in the ascendant that rectors actually formed a trade-union, and refused to marry or baptise except at enhanced prices. As late as 1800 some would refuse to open a prayer-book out of church for less than five pounds, six and eightpence.

This "beautiful" community (Peter was fond of using the adjective in this ironic way) Wolcot now joined. It necessitated a visit to England—that was all. On Saturday and Sunday, June 24th and 25th, 1769, the kinsman of the poet of Thebes was ordained first deacon, then priest, by Richard Terrick, Bishop of London. Horace Walpole said that Terrick's only episcopal qualifications were "a sonorous delivery and an assiduity of backstairs address."

Wolcot returned to Jamaica at the end of March 1770, about the same time as Chatterton, harbinger of the new spirit in poetry, came up to London. He found the expiring rector had unexpectedly recovered. Trelawney, who must have seen the ironic humour of the situation, kindly advised for his friend, physician and fiddler a new office, that of "Physician-General to all the Horse and Foot Militia raised or to be raised within this island." A few months later the small living of Vere fell vacant, and Wolcot became rector. No one took him seriously. "This," said a gentleman at a dinner-party, "is Dr. Wolcot, the unworthy incumbrance of this parish." After a few weeks the "incumbrance" had dropped all pretence of holding services, and was spending his Sundays shooting wood-pigeons.

The curtain now comes down with the rush of a storm upon Wolcot's Jamaican adventure. That fortune which was to have put him "beyond the caprice of a mob" seemed as far off as ever when in 1773 he obtained a year's leave of absence from his rectory, never to return. The reign of the Trelawneys was over. Malaria had ended the lives of the Governor and his daughter Ann. Lady Trelawney alone remained. It is said that Wolcot, as a last desperate throw, endeavoured to marry her—he certainly had had "designs" upon her daughter, whom he addressed as "The Nymph of Tauris." But even this failed, and the last months of 1773 see the Rev. Dr. Wolcot back in the West Country, setting about to get his living as a physician in Truro.

(*To be continued.*)

Reviews of Books

A New System of Scientific Procedure. By G. SPILLER. (Watts & Co., 10s. 6*d*.)

Textbooks on how to do this, that, and the next thing seem to be produced in great numbers nowadays. One of the latest is a long one (200,000 words) by a Mr. Spiller, and is highly instructive on the subject of pursuing original investigation. Books of this kind are a very modern product and, although greatly pooh-poohed in this country, are in vogue in the United States, where people are less cynical and sophisticated than here, less contemptuous also of the possibilities of youth. Readers of R. L. Stevenson's *New Arabian Nights* will remember that when the Reverend Mr. Simon Rolles had stolen the Rajah's diamond he found great difficulty in disposing of it because he could not find a textbook to give him the necessary information. It was true he was referred to a series of novels in which the ways of crime, including the disposal of stolen property, were dealt with authoritatively, but he could not help reflecting when he had read them all how annoying it was that the information he desired should be "scattered amongst romantic story-telling instead of being set forth soberly after the manner of a manual!"

But that was a couple of generations ago. Nowadays nearly every conceivable subject is set forth soberly after the manner of manuals. From them we learn how to double our incomes, to live to a hundred, to write short stories, or merely to assert ourselves or gain charm of manner. Some day, doubtless, a little series of books, green with yellow spots in colour, will appear in opposition to those of Mr. Pelman, teaching us how we may forget or how we may reduce our incomes, for these are about the only subjects one readily recalls on which a "How-to" textbook has yet to be written.

To return to Mr. Spiller. In his book he attempts to ascertain, develop and systematise the general methods employed in modern research work at its best so that all who are thinking of undertaking such work may be helped. The author regards it as an attempt at a modern statement of Bacon's position in his *Novum Organum*. He has asked himself how best may the human mind be made most effective for the discovery of scientific truth, and from a study of the work and methods of great men of science, the great pioneers, he has tried to give an answer. The author has set about his task with great energy and

considerable skill, and has evidently read widely. He has the gift of lengthened quotation. Anyone interested in either the theory or the practice of the scientific method will find this fascinating book of great interest and utility.

But can a man learn from a textbook anything that will help him to carry out original investigation? Many people affirm that such a thing cannot be taught, cannot be learned even by his working with a first-class investigator, much less from a book written by a man who has probably not done a stroke of experimental work in his life. But this is an old-fashioned view put forward largely by investigators who too optimistically assume that the qualities they themselves possess are native and special, while a truer view of the matter is that they learned them from their teachers much in the same way as they learned other things. Talent, whatever that word involves, an investigator must have, but definite instruction in research is necessary also. If original investigations were carried out exclusively by men of the calibre of Darwin, Kelvin, or Faraday one would argue on these lines with some diffidence, but of course this is no longer true. In olden days research was the hobby—pleasant, interesting, but entirely unremunerative—of a few. It could be pursued only by those who had private means or who earned a livelihood by other work. They were naturally men of great ability, and there was neither scope nor talent for those who possessed but ordinary ability. Nowadays things are vastly different. The field of science has extended enormously. Research is the order of the day. At some universities, indeed, it is compulsory in certain subjects for a bachelor's degree. There is work not only for the genius, but also for the man with five talents and for the man with one talent. For the last this book by Mr. Spiller should be of real service. It is by no means perfect, for such a book should be written by a small committee of experts rather than by one man. But it points the way, and it certainly offers a helping hand.

A. S. R.

The Analysis of Mind. By BERTRAND RUSSELL, F.R.S. (Allen & Unwin, 16*s.* net.)

To some of us, one of the most hopeful signs of the present age is the steady development of a New Psychology —a new attitude to life, that is to say, and interpretation of Man; which is not the system of any individual, but a synthesis of the results of many workers in very different fields. It is too soon yet to attempt a systematic description of the structure; but we can begin to discern the outline of the foundations, and to catch a vision of the happy new world that may be built upon them.

Very shortly, and in popular language, we may say that the principles emerging are these: that man is, fundamentally, a creature of instinct and intuition, not a "logical being"; his reasoning powers are his best tools (but only tools) for achieving his aim of harmonious self-expression; mind and body are but different aspects of a "neutral stuff"; his desires (objectively, his restlessness until satisfaction) can be turned to worthy ends, or unworthy ends, but cannot be destroyed. The chief contributions to this work have come from the study of comparative religion and anthropology; from examination of the problems of education (Professor Stanley Hall in America, and Dr. Montessori in Italy, to take two very different aspects); and, above all, from the vast new field of exploration opened up by Professor Freud's epoch-making work on nervous disorders and the interpretation of dreams. Mr. H. G. Wells's heroic attempt at a History of the World is a symptom of the same spirit.

In *The Analysis of Mind*, by Mr. Bertrand Russell, we have a welcome contribution from the standpoint of the mathematical philosopher. Here we find an admirably lucid statement of the problems of philosophical psychology (if we may use such a term to designate Mr. Russell's system of psychology; which is arrived at rather by logical analysis, than by the empirical, scientific methods of, say, Freud), and an attempted reconciliation of the conflicting views now current; with the further aim of bringing psychology into harmonious relations with the science of physics. Mr. Russell is, of course, much too acute a reasoner to accept all the doctrines advanced by too-enthusiastic investigators of this promised land—many of whom, indeed, have weak heads, and suffer from a sort of spiritual intoxication. It is just for this reason that the douche of his clear, cool logic is of such value. He is particularly good in his criticism of early Freudian doctrines, and the mistake of attempting to reduce all desire to a physical sex-hunger. Of the later developments of psycho-analytic theory, on very much broader lines, he is evidently unaware (indeed, they have not yet found considered and coherent expression in print) of the abandonment, that is, by many exponents, except in special cases, of the "censorship" theory; of the subdivision of the unconscious—which would better be called the "other-conscious"—into sub-conscious (instinct) and super-conscious (intuition); of the discovery that the unconscious often contains motives as much higher than the conscious ones as the Freudians discovered lower; all this he does not discuss. But his judgments on the earlier theories are so acute and unprejudiced that we may expect most illuminating and helpful criticism, when he has had time to study the new development. As it is, many of his conclusions are in complete agreement with the work done in other fields. This, for instance, which deals with the satisfaction of conscious desires which do not correspond with the more fundamental desires in the unconscious: "A secondary desire, derived from a false judgment as to a primary desire, has its own power of influencing action, and is therefore a real desire according to our definition. But it has not the same power as a primary desire of bringing thorough satisfaction when it is realised; so long as the primary desire remains unsatisfied, restlessness continues in spite of the secondary desire's success. Hence arises a belief in the vanity of human wishes: the vain wishes are those that are secondary, but mistaken beliefs prevent us from realising that they are secondary." Again, here is confirmation for those who say that in order to learn, children must be interested; and that flogging, or its modified equivalent, is no substitute (a thing which sounds obvious, but is constantly neglected in our schools—teachers being

often unable to interest the children, and thus resorting to other methods). "Learning is only possible when instinct supplies the driving force. The animals in cages, which gradually learn to get out, perform random movements at first, which are purely instinctive. But for these random movements they would never acquire the experience which afterwards enables them to produce the right movement." And this, as to what can, and cannot, be inferred from an examination test. "There is obviously an observable fact called 'knowing' such-and-such a thing: examinations are experiments for discovering such facts. But all that is observed or discovered is a certain set of habits in the use of words. The thoughts (if any) in the mind of the examinee are of no interest to the examiner; nor has the examiner any reason to suppose even the most successful examinee capable of even the smallest amount of thought." In its context this quotation is less startling than it sounds isolated. Mr. Russell has been showing that all our knowledge apart from instinct (and one would like to add intuition) may be adequately described as "behaviour-habits"; and it is these, and these alone, which we test in an examination.

But it is difficult for the philosopher not to exalt the reason into the master of man; instead of the tool, or, at the best, the collaborator, of his instinctual and intuitive nature. Even Mr. Russell writes: "Psycho-analysis, as everyone knows, is primarily a method of understanding hysteria and certain forms of insanity; but it has been found that there is much in the lives of ordinary men and women which bears a humiliating resemblance to the delusions of the insane." The thorough-going Neo-humanist would rather write: "For many hundreds of years man was oppressed by the humiliating belief that members of his species were liable to behave in a totally irrational manner, destructive of the self and of the race. It has now been discovered that in most such cases (and it probably will be discovered that in all such cases) there is present the essentially sane instinct of self-development; the apparent madness is due to a natural reaction to an impossible environment, or to the logical principle in man choosing a mistaken means of achieving a perfectly reasonable end—an accident that is liable to happen to any of us." Thus mad people cease to be a perpetual question-mark (like the figure of Death in Hans Holbein's pictures) to the sanity of mankind, and become, like other sick people, a stimulating challenge to us to develop our faculties and discover the proper way of curing them.

D. N. Barbour.

Books Received

(Books mentioned in this column may or may not be reviewed elsewhere in this number, or in a later number.)

FICTION

The Master of Man. The Story of a Sin. By Hall Caine. (William Heinemann, 6*s.*)

Karma and Other Stories and Essays. By Lafcadio Hearn. (George Harrap & Co., Ltd., 5*s.*)

HISTORY AND ECONOMICS

Spain since 1815. By the Marquis De Lema. (Cambridge University Press, 4*s.* 6*d.*)

A Digest of British Economic History. By F. H. M. Ralph, M.A., and W. J. N. Griffith, B.A. (John Murray, 5*s.*)

A concise and stimulatingly-written introduction to British Economic History. Starting with the Stone Ages, the authors bring us down to the complicated economic and social conditions of the present day. We note as particularly interesting the chapter on the mediæval guilds, that on the economic problems and theories of the early nineteenth century, in which the views of Adam Smith, Malthus, and Ricardo are clearly analysed, and the concluding chapter on the effect of the development of Trade Unions and the various tendencies of socialism. Not the least amongst the virtues of this survey is its politically unbiassed attitude to its subject. We confidently recommend it not only to schoolmasters, but to adults, whom the war has stimulated to a study of economics.

Prehistory. By M. C. Burkitt. (Cambridge University Press, 35*s.*)

LITERARY CRITICISM

The Tale of Terror. A Study of the Gothic Romance. By Edith Birkhead, M.A. (Constable & Co., Ltd., 15*s.*)

Bibliography of English Language and Literature, 1920. Compiled by Members of the Modern Humanities Research Association. (Bowes & Bowes, Cambridge, 3*s.*)

A scientifically-compiled catalogue of books published throughout Europe and the British Empire on the English Language and Literature. The main headings in the Language section are *Vocabulary, History of Language and Grammar, Phonetics, Metre, and Style*; the main headings in the Literature section are *Old English, Middle English, Old and Middle English: Subsidiary, Modern English.* As an example of the careful methods employed, the *Modern English* sub-section is further subdivided into sections dealing with the work of each century from the sixteenth to the twentieth, under the headings *General* and *Authors.* An extremely good three-shillingsworth for lecturers and students concerned.

MISCELLANEOUS

Fabre: Poet of Science. By DR. C. V. LEGROS.

A second impression of a book first published in 1913, which gives an account of the life of one whom Darwin described as "an inimitable observer" of insects and small animals.

From a Modern University. Some Aims and Aspirations of Science. By PROF. ARTHUR SMITHELLS, F.R.S. (Oxford University Press, 12*s.* 6*d.*)

Occasional addresses given before 1914 on the relation of the modern Universities to the world, on the relation of science to life, on classical and scientific curricula in schools, and allied subjects. Well-informed and interesting. Like Prof. Soddy's book, *Science and Life*, on similar subjects, it suffers through being a collection of addresses and not a continuous book. A discussion by these authors of the subjects of this book embracing the lessons taught by the war, particularly with regard to the relation between both the modern and the older Universities and public life, would be a valuable one. A book on these lines is badly wanted.

A Short History of Newnham College, Cambridge. By ALICE GARDNER, M.A. (Bowes & Bowes, 7*s.* 6*d.*)

A singularly interesting account, by a former Fellow and Lecturer of Newnham, of the rise and growth of her old college. In the autumn of 1871 a house was found in Regent Street, Cambridge, and Miss Clough (sister of the poet) and five students began their common life in a new stage in the movement for the higher education of women. They had few comforts, no garden, no games, not a little opposition, and many battles to fight. To-day Newnham is large and flourishing, with four halls of residence, well staffed, well equipped, and with a tradition of which every woman who has passed through her gates is proud. The book is dedicated to two who did much for Newnham in the early days—Miss A. J. Clough and Henry Sidgwick. It is not in the least controversial in tone, but the case for the admission of Cambridge women to higher degrees is well put.

A Philosopher with Nature. By BENJAMIN KIDD. (Methuen & Co., Ltd., 6*s.*)

Some Birds of the Countryside. The Art of Nature. By H. J. MASSINGHAM. (T. Fisher Unwin, Ltd.)

Our Title and Its Import. The Presidential Address for 1920–21, delivered at Bedford College by PROF. OTTO JESPERSEN. (Publications of The Modern Humanities Research Association, No. 4. Bowes & Bowes, Cambridge, 1*s.*)

PHILOSOPHY

The Reign of Relativity. By VISCOUNT HALDANE. (John Murray, 21*s.*)

A Treatise on Probability. By JOHN MAYNARD KEYNES. (Macmillan and Co., Ltd., 18*s.*)

PSYCHOLOGY

The Analysis of Mind. By BERTRAND RUSSELL, F.R.S. (G. Allen & Unwin, 16*s.*)

The Beloved Ego. By DR. W. STEKEL. (Kegan Paul, 6*s.* 6*d.*)

The International Psycho-Analytical Library. Edited by ERNEST JONES. (The International Psycho-Analytical Press and George Allen & Unwin.)

No. 1. *Addresses on Psycho-Analysis.* By DR. J. J. PUTNAM. Price 17*s.* 6*d.*

No. 2. *Psycho-Analysis and the War Neurosis.* Price 7*s.* 6*d.*

Dr. Putnam was Emeritus Professor of Neurology at Harvard, and one of the earliest, and latterly the most distinguished, exponents of psycho-analysis in the United States. This book contains twenty-two papers written between 1909, when the author became interested in the movement, and 1918, when he died. They are written in a charming style, revealing the outlook of a large-minded and particularly sane American. Most are of an expository nature. They show (as Dr. Freud points out in a short introduction) how the writer accepted the essence of psycho-analysis, recognised its capacity for throwing a clear light upon the origin of human imperfections, and how he was struck by the prospect of contributing towards the improvement of humanity along analytical lines; how he then became convinced by his own activities as a physician as to the truth of most of the psycho-analytical conclusions and postulates, and then in his turn bore witness to the fact that the physician who makes use of analysis understands far more about the suffering of his patients and can do more for them than was possible with the earlier methods of treatment; and, finally, how he began to extend beyond the limits of analysis, demanding that as a science it should be linked on to a particular philosophical system, and that its practice should be openly associated with a particular set of ethical doctrines The book may be recommended to those who have some knowledge of psycho-analysis as heartily as one would recommend a good volume of sermons.

The second volume contains an article on war shock and Freud's theory of the neuroses, by Dr. Ernest Jones, and three papers on similar subjects read at a Congress at Budapest in 1918. A technical work for advanced students.

SCIENCE

The Scale of the Universe. By HARLOW SHAPLEY, Mount Wilson Observatory and Carnegie Institution of Washington, and HEBER D. CURTIS, Director Allegheny University. (Bulletin of the National Research Council of the National Academy of Sciences, Washington, D.C., 60 cents.)

A Manual of Seismology. By CHARLES DAVISON, Sc.D. Cambridge Geological Series. (Cambridge University Press, 21*s.*)

A book which may be heartily recommended to students of Earthquake Phenomena.

Electrons and Ether Waves. By SIR WILLIAM BRAGG, F.R.S. (Oxford University Press, 1*s.*)

See first article in this number.

The Ether Stream. An Explanation of the Cause of Gravitation. By J. S. MILLAR. (Watts & Co., 2*s.* 6*d.*)

Unscientific and untrustworthy.

Ameboid Movement. By PROF. ASA A. SCHOEFFER. (Princeton University Press and Oxford University Press, 10*s.* 6*d.*)

A monograph by the Professor of Zoology in the University of Tennessee.

Insects and Human Welfare. By CHARLES THOMAS BRUES. (Cambridge: Harvard University Press. London: Oxford University Press. 10*s.* 6*d.*)

This is an account, by an Assistant Professor of Economic Entomology at Harvard, of the more important relations of insects to the health of man, to agriculture, and to forestry. The chapters deal with insects and the public health, insects and the food supply, forest insects, household insects, and the outlook for the future. The past few decades have witnessed great changes whereby the field of the entomologist has been greatly extended, and here in a form neither too technical nor too "popular" is an account of the progress made. The book is well illustrated and may be heartily recommended to readers.

The Control of Life. By PROF. J. ARTHUR THOMSON, M.A. LL.D. (Andrew Melrose, 7*s.* 6*d.*)

The Electric Furnace. By J. N. PRING, M.B.E., D.Sc. (Longmans, Green & Co., 32*s.*)

Thermionic Tubes in Radio Telegraphy and Telephony. By JOHN SCOTT TAGGART. (The Wireless Press, 25*s.*)

Correspondence

To the Editor of DISCOVERY

DEAR SIR,

Have you not been less than fair to the reputation of Paul Gauguin (1848–1903) in your article entitled "Revolutionary Movements in Modern Painting" in the current number of DISCOVERY? Gauguin gave up his occupation and means of subsistence late in life, in order to devote himself exclusively to his art. Finding that he could not free himself from the trammels of artistic and other conventions in France, he forsook all, went alone to Tahiti, and subsequently to the less frequented Îsles Marquises, where he died alone. By the studied simplicity of his work and its avoidance of all unnecessary detail and definition, he tried to point the way to a greater freedom of expression and to make painting a universal language, which no one with an artist's vision need be afraid to use for lack of training. He would have endorsed a saying attributed to Dégas that it is only the bad painters who are not artists. There can be no doubt that Gauguin's fame continues to increase as his work and its meaning become more widely known.

No one accustomed to look at such things could fail to be struck by the beauty of design and decorative qualities of this master's work, as seen in black-and-white in the well-illustrated French monograph. To come unexpectedly upon the original of one of these illustrations, as the present writer did recently in an art dealer's shop window in Paris, is an astounding revelation of how such beauty of design can be enhanced by brilliancy of light and colour. A superficial observer of this picture might easily have supposed that the whole effect was produced by these latter qualities, though the subject was an early portrait group of a brother painter and his family in his studio, and not one of Gauguin's later gorgeous tropical scenes.

Yours faithfully,
HENRY L. P. HULBERT.

THE COTTAGE, BRIXWORTH,
NORTHAMPTON.
August 10, 1921.

To the Editor of DISCOVERY

DEAR SIR,

After reading Dr. Russell's very interesting article on Isotopes, I am emboldened to ask him a question which has been in my mind to put to him since Mr. Darwin's article in February 1920. Mr. Darwin gave a list of the chemical elements based on Moseley's atomic numbers from 1 to 92, and evidently he and Mr. Russell are of opinion that, once we have found the few undiscovered elements between those numbers, science will be more or less satisfied.

Now, I have read in my very discursive readings that there are two elements which have been actually discovered external to the Earth, namely, Coronium in the sun, and Nebulium in the stars, but somehow it seems to me that neither of these elements will fit in with those undiscovered elements in Moseley's list. Will you be kind enough to ask either of these gentlemen if it is a fact that these two elements do exist, and that being so, what do they imagine their atomic numbers to be?

Yours faithfully,
GEO. C. WILLIAMS.

99 MERCER'S ROAD, N.19.
July 31, 1921.